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## CONTENTS.

☞ An asterisk (*) denotes an illustrated article


EDITORIALS—
An Outrageous Bill.....181
Proceedings of the Society of Arts, London—Chemical Section—Electric Lighting.....181
Official Report, etc.....187
Eighth Annual Meeting of the New England Association of Gas Engineers.....187
On Some New Contributions to the Chemical and Technical History of Coal Gas.....190

CORRESPONDENCE—
Gas Notes from Ohio.....192
How to Burn Gas.....193
Gas-Light Intelligence.....193
Prices of Gas Coals.....193



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## AN OUTRAGEOUS BILL.

A bill has been introduced into the Legislature of this State, fixing the price of gas *according to the population* of the place where it is used, at various rates, from $2 per thousand feet upwards.

The standard of illuminating power is to be that of sixteen candles, each burning at the rate of *one hundred and thirty-two* grains of sperm per hour. Where the statesmen obtained this number as a proper one for the amount of sperm consumed, instead of the 120 grains usually used all over the world, it may be difficult to determine. The effect would be to raise the standard higher than it purports to be in the bill.

Several other provisions in this bill are worthy of note.

Any failure to keep the gas up to the new standard is to relieve every one to whom the gas below the standard has been furnished, from paying anything therefor, and also entails a fine of one hundred dollars upon the company furnishing it which one hundred dollars is to go to the informer. This would make the manufacture of gas an interesting kind of business. The whole thing is simply an outrage, a species of communism; and, nevertheless, the bill has passed to the third reading in the House.

Why not pass a law regulating the price of a barrel of flour, a pair of shoes, a barrel of petroleum, or pork, or beef, a paper of pins, or a box of percussion caps? These things are needed by almost every one; and if a law is not passed to regulate the price of them, some one might make a profit on their sale. The great mystery about this kind of legislative business is that it goes to the extent that it does. There is barely a year passes but some such bill as this is presented, and started on its passage, not only in this State, but in almost every other in the United States.

Common honesty ought to assert itself occasionally, even in a State Legislature, and there ought not to be any such blots upon the records of any legislative body as these bills certainly are. It may all be very well for "buncombe"; but a record for fair dealing should be much more valuable to aspirants for political exaltation in any community, than a reputation for advocating unfair and oppressive measures.

## PROCEEDINGS OF THE SOCIETY OF ARTS, LONDON.

### Chemical Section.

Thursday, March 28; R. J. Mann, M.D,. in the chair.

The Paper read was—

### ELECTRIC LIGHTING.

By DR. PAGET HIGGS.

I feel that it is great good luck that I am among the first to bring to the notice of this Society, so great a pioneer in the application of science to industrial arts and manufactures, some details on the subject of electric lighting. This subject is not only now of the highest importance to certain technical classes, it also gives promise of development to matters concerning our lives as private individuals. As a mode of public illumination it has attained definite success.

Time was when subjects still in the domain of science were very far from industrial realisation; to-day an invention or discovery is in the hands of the investigator in his laboratory; to-morrow it is universally applied, and the world wonders how it ever did without it in its absence. The railway and the telegraph are not very ancient inventions; there are still living many thousands who have travelled by stage-coach and thought ten miles an hour wonderful speed; and the telegraph is not yet a generation old. We all have heard of the telephone. We know that it can be used for five hundred miles or more on a practical telegraph line; two years ago, had we been told that we could hear our friends laughing a day's railway journey distant, we should have regarded our informant as indulging in tall talk. A few months ago many of us had never heard of the phonograph, now we know that we can effectually register speech.

With these precedents, how can we say that electricity, which is even now far removed from the *role* of a mere laboratory aid, may not, in perhaps some such short period, be a means of illumination generally adopted. At the present moment, as far as I know, there is no competition between our present means of illumination, namely, gas lighting and electric lighting. I use the term no competition, because these two illuminating methods have, at the present time, two distinct fields. Electricity is still at a disadvantage in its application to the lighting of small spaces, or where many small lights are required. Gas is not advantageous in the lighting of large spaces.

It might also be said that it is under considerable disadvantages in the lighting of public thoroughfares; and that, when it is employed for the lighting of large engineering or open air works, it is absolutely ineffective. By its aid, also, it is impossible to distinguish colors, however brilliant or perfect its light may be. It is well known that blue and green—unless the latter be a so-called gas-light green—cannot be distinguished in gas-lighted rooms. Further, even in large enclosed spaces, the use of gas is attended with a deterioration of atmospheric purity prejudicial to health. With the electric light, on the contrary, not only does the light leave the oxygen of the air unconsumed and uncontaminated, but, by generating ozone, it might be said to act as a purifier. That this generation of ozone is not inconsiderable is known to every one who has stood within a few yards of the electric light. For this reason alone we should look forward with increased interest to the probability of electric lighting in its domestic application.

In the course of this paper I shall endeavor to show the relative economies of electric lighting and gas lighting as applied to manufacturing industries. But electric lighting, supposing that its economy would not be less than that of gas, would still have many and important advantages over gas lighting in certain cases. For instance the intensity of its light admits of large works of an engineering or constructive character being carried on practically, as well by night as by day. No method of gas lighting has yet attained this position. In silk mills, dye works, picture galleries, stores, etc., where to distinguish colors by night as by day enables the manufacturer or vendor to labor continuously, gas lighting must again give place absolutely to electric lighting; for by the electric light scenes are painted, rooms decorated, delicate colors assorted, and looms fed as well as by day.

The advantages of the electric light have also been found in shipbuilding, and with ships themselves upon the ocean; it is unrivalled for lighthouse applications, and it promises to afford a means to the submarine diver that daylight itself has not achieved.

In the fine arts, it will undoubtedly, be used to illuminate our picture galleries, as it is now used to light portions of the Louvre at Paris. To photography it has given so much assistance that your sun-picture may be taken by this artificial sunlight at midnight. Of its use in war, in detecting the movements of attacking armies, the course of torpedo boats, etc., it is unnecessary here to say anything.

The applications thus briefly noted are to be regarded as accomplished facts. In soliciting your attention to the description and details that follow, it is necessary to state definitely and decidedly that the application of the electric light to industrial purposes is no longer a commercial idea, but that in consequence of the recent rapid marked improvements in electro-magneto apparatus, electric lighting demands the attention of every manufacturer and constructor, not only as a system of lighting superior to any other in use for his purpose, but because by it results may be had that have hitherto been unattainable.

Electric lighting, as a system for lighthouse illumination and experimental purposes has been known for some years, but from the large space occupied by the magneto-electric machines, their cost, and the high motor power required to drive them, its practical use has been limited.

Going back to first principles, we have that of magneto-electricity as discovered by Faraday. His experiment with a bar of iron surrounded by a coil or spiral of wire, and the production of electric currents in the coil by approaching to or drawing a magnet from the bar, and the correlative laws, are well known. Pixii, in 1833, constructed the first magneto-electric machine, upon which Saxton and Clarke improved. With these machines an electric current was obtained by causing permanent magnets and coils of wire to revolve with their poles in juxtaposition. Nollet, of Brussels, improved and enlarged Clarke's machine, and modifications of this machine have been constructed by Holmes, of London, and the Compagnie l'Alliance, of Paris. In 1854, Dr. Werner Siemens, of Berlin, improved the revolving coil giving to all magneto machines with permanent magnets, what may be considered, at the present time, as the final step in this description of machine. But electric machines with permanent magnets are disadvantageous in use, because increased dimensions (beyond certain limits) do not give increased electrical results.

Magneto-electric machines (with electro-magnets) of the present powerful construction are due practically to Dr. Siemens and Sir Charles Wheatstone, who, within a short period, independently discovered the principle of accumulation by mutual action. Taking advantage of the fact that iron always has a certain amount of magnetisation said to be residual or remanent, these inventors cause a coil of wire to revolve between the poles of an electro-magnet which is in electrical circuit with the coil itself. Starting with the current induced in the coil by the residual magnetism, this current passes from the coil to the electro-magnets, making them more powerfully magnetic, and giving rise to still more powerful currents in the coil.

Magneto-electric machines based upon this principle are now in use under two forms of construction. Of these forms, I have only one to show you, namely, the Siemens machine. The machine invented by M. Gramme, of Paris, and extensively used in France, I do not purpose to describe, as the results obtained by both machines are so similar, that a description of one will afford understanding of the other. However, in dealing with the question of economy, I shall borrow largely from the published results given by Mr. Gramme, as aiding to show the advantages of electric lighting from the point of view of two independent sources.

In the latest form of construction of the Siemens magneto-electric machine, the armature, as the revolving coil may be called, consists of several lengths of insulated copper wire coiled in several convolutions upon a cylinder, as shown in transverse section in Fig. 1, in longitudinal section in Fig. 2, and in perspective view in Fig. 3. The whole surface of the cylinder is covered with wire, laid on in sections, each convolution being parallel to its longitudinal axis. For about two-thirds of its surface, the wire cylinder is surrounded by curved iron bars, there being just sufficient space left between these curved iron bars and the wire cylinder to allow of its free rotation. The curved iron bars are prolongations of the cores of large flat electro-magnets; the coils of these electro-magnets and the wire on the cylinder (from brush to brush) form a continuous electrical circuit. On revolving the cylinder (which is supported upon a longitudinal axis in suitable bearings, the axis carrying a pulley) an initially weak current is generated into its wires by their passage through the magnetic field formed by the residual magnetism of the iron cores of the electro-magnets, and the current being directed into the coils of the electro-magnets, increases the magnetism of the cores, which again induce a stronger current in the wire cylinder. This mutual action may continue until the iron has attained its limit of magnetisation. The maximum magnetic power acting upon each convolution is attained at every revolution of the armature, when the convolution passes through the centre of both magnetic fields, and gradually falls to zero as the convolution becomes perpendicular to that position. Each convolution has, therefore, a neutral position, and a convolution leaving that position on the one side of the axis, and advancing towards the north pole of the electro-magnet, would be subject to a direc-induced current, and that portion of the convolu tion on the opposite side of the axis would be traversed by a current of opposite direction, as regards a given point, but of the same direction as regards circuit.

Each of the sections of wire coiled upon the cylinder consists of two separate coils, leaving four ends; two of these ends are connected to each of the segments of a circular commutator divided into parts. But all the coils are connected to the several segments of commutator in such a manner that the whole of the double sections form a continuous circuit, but not one continuous helix.

Two brushes, placed tangentially to the segments of the commutator, collect the electric currents; these brushes are connected one to each electro-magnet, and the two free ends of the electro-magnet coils are connected to the conducting wires leading to the lamp.

The dimensions, weight, number of revolutions made by the armature, light equivalent in normal candles, and horse power required for driving, are for three sizes of machines as follows:

| Dimensions in inches. lgth. | wdth. | hght. | Weight in lbs. | Revolutions of cylinder. | Candles' light. | H. P. |
|---|---|---|---|---|---|---|
| 25 | 21 | 8·8.. | 298.. | 1,100.. | 1,000.. | 1½ to 2 |
| 29 | 26 | 9·5.. | 419.. | 650.. | 6,000.. | 3½ to 4 |
| 44 | 28·3 | 12·6.. | 1,279.. | 480.. | 14,800.. | 9 to 10 |

The lamp which it is preferred to use with the Siemens machine is as follows:

If the carbons be inserted in their holders, they will, on their points being separated, be brought together again by the gravitation of the top carbon and its holder. The descent of the top carbon actuates, by means of the straight rack it carries at its lower end, a large pinion, the spindle of which carries a small pinion gearing into a second neck attached to the lower carbon holder, the superior weight of the top carbon and holder in conjunction with the multiplying ratio of the two pinions producing a continual tendency of the carbons to approach each other. The large and small pinions are connected to each other, and to the spindle that carries them, by an arrangement of friction discs, and the object of this construction is to allow of the two racks being moved equally and simultaneously up or down for the purpose of focussing the light when required. This movement is effected by means of bevelled gearing actuated by a milled head which can be pressed into position when required. On the spindle carrying the large and small pinions and the friction discs, is placed a toothed wheel connected with the spindle by a pawl and ratchet. This wheel is the first of a train of wheels and pinions driving a regulating fly in the usual way. The pawl and ratchet are provided to allow of the rapid distancing of the carbon holders when it becomes necessary to introduce fresh carbons. The spindle of the fly also carries a small finely-toothed ratchet wheel. This ratchet wheel is actuated by a spring pawl, carried at the end of a lever, which lever is the continuation of the armature of the electro-magnet, in such a manner that when the armature is attracted by the electro-magnet,

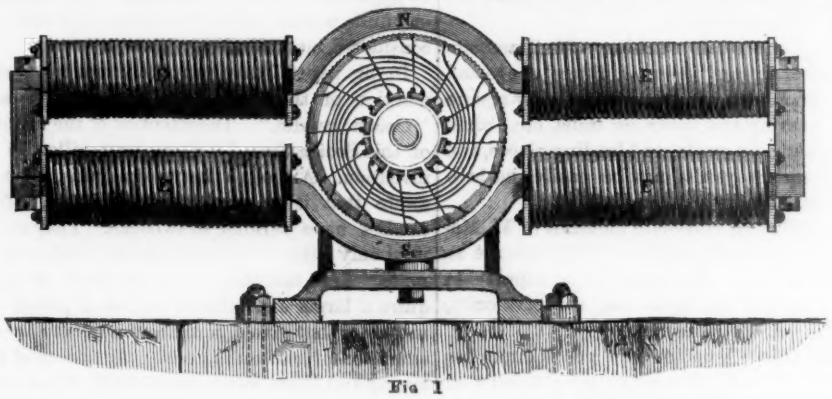

Fig 1

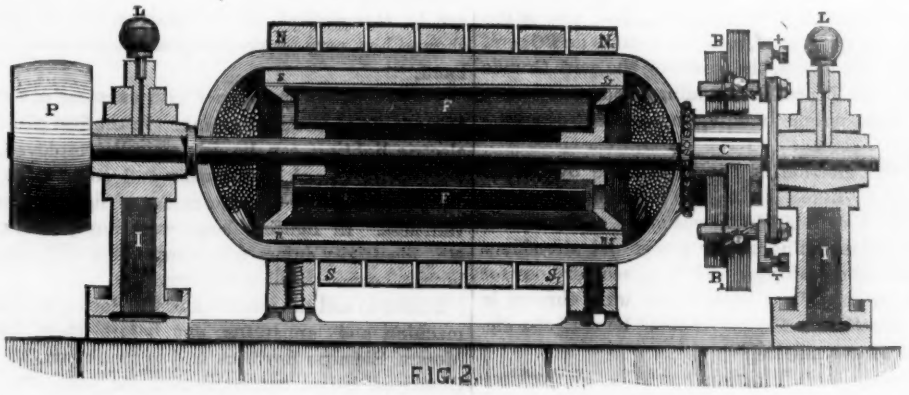

FIG.2.

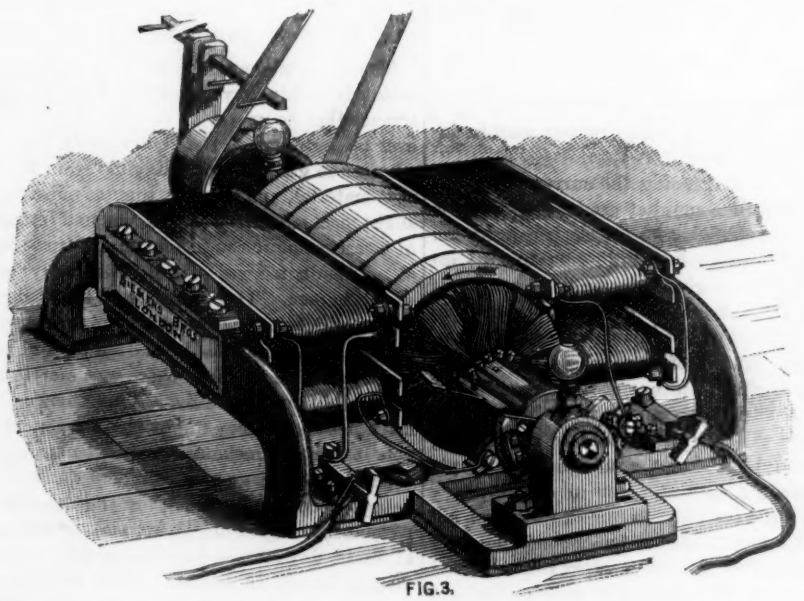

FIG.3.

the spring pawl engages in the teeth of the ratchet wheel and causes the wheels in gearing therewith to act upon the racks of the carbon holders to draw them apart.

The action of the lamp is as follows :—The current passes from the conductor to the top carbon holder, thence through the carbons to the bottom carbon holder, then to the coils of the electro-magnet situated in the base of the lamp. From the coils of the electro-magnet the circuit is completed to the other conductor. Upon the current passing through the circuit, the armature of the electro-magnet is attracted, and the abutment from the armature lever caused to short-circuit the coils of the electro-magnet, releasing the armature. The armature being released, the short-circuit is removed from the coils of the electro-magnet, and the cycle of movement repeated ; in this manner an oscillatory movement is given to the armature lever, which, by the spring pawl, actuates the ratchet wheel, the train of clockwork, and the racks of the carbon holders, forcing the carbons apart until the distance between their points sufficiently weakens the current, so that it no longer attracts the armature of the electro-magnet. Thus, by the combined action of gravitation of the top corbon in drawing the carbons together, and of the current to separate the carbons when they approach too closely, a working distance is maintained between the points with perfect automatism.

Magneto-electric machines have chiefly been employed for the production of the electric light, but they are also applicable for the transmission of power and for electro-metallurgical processes. In this paper we shall confine our attention to their use for the production of the electric light.

With regard to the improvements in recently constructed dynamo-electric machines, we learn from Professor Tyndall's report to the Elder Brethren of the Trinity-house, that magneto-electric machines of old construction cost ten times more, occupied twenty-five times the space, and weighed fourteen times as much as the recent machines, while they produced only one-fifth of the light, with practically the same driving power ; that is to say, taking light effect in each case into consideration, the new machines cost one-fiftieth, and are, as regards space occupied, a hundred and twenty-five times more advantageous than the earlier forms.

Against the use of magneto-electric machines for practical purposes, there has been quoted the disadvantage of stoppage due to wear and renewals, but in the present form of machines the chances of stoppage are more than those that arise generally with machines of any ordinary construction. The Trinity-house report, previously referred to, states that the Siemens machine then tried "worked well from the 7th March to the 7th April without any necessity for a stoppage. On the 11th March the commutator plates and brushes were again adjusted ; and on the 6th April, the commutator plates and brushes were renewed."

The limit to the duration of the light is at present set by the size of the carbons and the rate of their consumption, which depends much upon the power and quantity of the current, and consequently upon the size of the machine employed. In the lamps shown in the accompanying drawings, the lower carbon is eight inches, the upper carbon sixteen inches in length, and the holders are arranged to receive a round or square carbon of nine to twenty-one millimetres diameter or side. Eight to ten hours is the longest time of duration of the carbons. Attempts have been made to construct lamps with the carbons in the form of circular dies set edge to edge, and caused to revole by clockwork in order to lengthen the duration of burning, and a lamp so constructed by M. Regnier has been said to have given good results, but the difficulty of obtaining homogeneous carbons may be considered to be insuperable to the practical introduction of this lamp.

I now come to the more interesting portion of any paper, that relating to the efficiency of electric lighting, and its comparison with methods of gas lighting. We may assume, I believe, without fear of contradiction, that gas cannot be manufactured under a cost, including working profits, of two shillings for one thousand cubic feet as an average price. A gas burner of twenty candles light will certainly consume six cubic feet of gas per hour. Eight thousand candles light would necessitate four hundred burners, consuming two thousand four hundred cubic feet of gas per hour, costing four shillings and nine pence. The cost of fixing gas pipes, burners, cocks, etc., at ten shillings per burner, pipes included, would be £200. Assuming three hundred working nights, with an average time for lighting of five hours per night, or fifteen hundred hours, and reckoning cost of renewals, repairs, and shifting with work in progress, to be included in an interest of twelve per cent. per annum, we have—

| | | | |
|---|---|---|---|
| Interest on £200..... | £ | 24 | 0 |
| Cost of gas for 1500 hours... | | 356 | 5 |
| | £ | 380 | 5 |

If only five hundred hours were worked during the year the cost would be—

| | | | |
|---|---|---|---|
| Interest on £200..... | £ | 24 | 0 |
| Cost of gas..... | | 118 | 15 |
| | £ | 142 | 15 |

The cost of a magneto-electric giving this light intensity, with lamp and steam motor and connecting wires, would not exceed £250. The cost per hour for carbons, coals, attendance, oils, renewals, etc., may be taken at two shillings per hour under the most unfavorable conditions. This gives—

| | |
|---|---|
| Interest on £250 | £ 30 |
| 1,500 hours at two shillings | 150 |
| | £180 |

which is a ratio in favor of the economy of electric lighting of 2·1 to 1.

If five hundred hours' lighting be taken, the cost for the electric light would be £80, or in the ratio of nearly 1·8 to 1 in its favor. But this is not strictly a just method of estimating the value of the electric light, because the one lamp will brilliantly light a space which would be so badly illuminated by the distributed gas-burners that work could not be carried on except under great inconveniences.

An actual comparison of these methods of lighting may be made by referring to some data given by Messrs. Siemens Brothers from the system as employed by them in one of the departments of their telegraph works, which, previous to the introduction of the electric light, was imperfectly lighted with 120 gas burners. The imperfection of the light, and the progress of the work necessitated frequent alterations in the gas fittings. Each of the burners consumed six cubic feet of gas per hour at a cost of three shillings and nine pence per thousand. The cost of fixing gas pipes including cost of pipes, burners, cocks, etc., for the whole number was £60; interest may be taken at 15 per cent., to include wear, tear, renewals and removals, per annum. During extensive orders, day and night work are continuous, and one thousand hours' consumption per annum is below the actual expense.

| | | | |
|---|---|---|---|
| Interest | £ 9 | 0 | 0 |
| Cost of gas consumed | 135 | 0 | 0 |
| | £144 | 0 | 0 |

The 120 burners will give only 2,400 candles' light, actually; but a per centage of this is attained, and with steam or fog the gas jets are obscured. It is necessary to employ three lights for the three spaces to be lighted. Three machines, with lamps, conducting wires, and mounting, etc., cost £250.

| | | | |
|---|---|---|---|
| Interest at 15 per ct. on £250 | £ 37 | 10 | 0 |
| Carbons, coals, attendance, renewals, &c., for 1,000 hours. | 35 | 4 | 0 |
| | £ 72 | 14 | 0 |

This is an economy of 2 to 1 in favor of electric lighting; but, if the ratio of light intensities were adopted, the advantage would be as 6 to 1 in favor of electric lighting.

The economy varies with the motor power; the light is cheapest when water power is to be had, and most expensive when a gas-engine is employed. At M. Dieu's workshop at Davours, with the Gramme machine, the cost per hour is 1s. 11d., against 2s. for gas. M. Ducommum states that the electric light costs two and a quarter times less than gas-light, when wear, tear, and interest are taken into consideration.

It must not be forgotten that, in calculating these relative costs, the gas is taken as supplied to other consumers than the works in question. If it were necessary to construct a special gasworks, requiring special technical knowledge and attention, where the waste products of the gas manufacture could not be utilised, the cost of the gas would rise to 10 to 12 times that of electric lighting, and in many cases would be absolutely inapplicable under conditions where the electric light might be easily instituted.

Generally, one small machine will illuminate five hundred square yards of fitters' shops and machine shops, and two hundred and fifty square yards of weaving and spinning mills, etc., while in the open air, on yards, and landing places, two thousand square yards may be easily and brilliantiy illuminated with a single lamp.

In the celebrated chocolate factories of M. Ménier, 14 machines are employed, and these are so arranged that the electric light can be supplied to the drawing and dining-rooms, conservatories, and gardens of the residence.

At Paris, the Chapelle-Paris goods depot has been provided with the electric light, with an economy in the staff of twenty-five per cent., for the reason that work can be carried on so much more expeditiously.

The electric light is in use in Paris, also in the magazine du Louvre, and the Avenue de l'Opera, the *Figaro* offices, the works of the new Grande Hotel, the Exposition buildings, and nearly every important public building in course of construction.

In the erection of the Tay-bridge by Messrs. Hopkins, Gilkes, & Co., two machines were employed, distant 300 hundreds apart. The cost of working, including motor power and attendance was about one shilling and fivepence per hour for each lamp. When both lights were thrown in one direction, a newspaper could be read at a distance of two miles.

Messrs. Head, Wrighton, and Co., of Stockton-on-Tees, have employed the electric light for night-work for about three months, during which time the interest on the outlay, superintendence, and cost of carbons was fully covered by the charge of one shilling per hour for a thonsand candles light.

These typical cases will serve to show that electric lighting supplies a long existing want in industry.

The methods of utilising the current for light purposes are still somewhat crude and there is much yet to be done before the electric light can be employed with comfort in illuminating rooms and halls of ordinary dimensions. A source of inconvenience is the want of chemical purity in the carbon rods, but this inconvenience is not apparent in the lighting of large spaces, and, doubtless, when an efficient means of tapping or subdividing the electric current has been devised, the electric light will take the position of gas lighting in every household. And, although the attempts to subdivide the current, so as to obtain many smaller lights, have only promised, but have not attained success, I believe, I may conclude, as I have mentioned in the introductory remarks, that we cannot say how soon this may be brought about. Indeed, I have in the laboratories of my friends, both in England and France, seen arrangements in action that go very far to fulfil what is required, and I should not be surprised at any moment to learn that the difficulties have been overcome, and that the future means of illumination for all purposes would be electricity.

In utilising the electric light, the lamp is sometimes, as in lighting large spaces, unprovided with glass or shade; in other cases opal and milk glass globes are used to soften the light; but both these methods cause fatigue to the eye, when the operator or workman has the habit of looking directly at the light. To obviate fatigue from the direct rays, it has been proposed to place the electric focus in a reflector, and to project the rays upon a whitened ceiling, or upon another reflector, so as to diffuse a soft and pleasant light throughout the room. This method would also be applicable for street lighting, in thoroughfares or public places where the direct rays might be considered inadmissable.

In this paper I have purposely omitted to make mention of the Jablochkoff lamp, or so-called "electric candle." The attention of the members of this Society has, I believe, been called to this invention. Although in use in Paris, I am not aware that it is employed in England. These candles have serious drawbacks. They can be used only with a machine giving alternate currents. Such machines, for equal light effects, require a larger expenditure of motor power than machines that give a permanent current; the consumption of carbon is greater than in an electric lamp; and these disadvantages will, I am afraid, interfere with the extended introduction of this system of electric lighting. To M. Jablochkoff is, however, due the merit of opening up a new era in this method of illumination, because he showed how very nearly practical results were at hand.

I may conclude this paper with a resumé of the advantages of electric lighting. In the first place electric lighting can be economically employed, both with regard to intensity and color effect, where gas-lighting or other modes of lighting are valueless. In lighting large workshops, stores, etc., electricity enters into competition with gas, both in economy and safety from fire.

I have to call the attention of the Society to the machine and apparatus put before them by Messrs. Siemens Brothers, and to thank you, Mr. Chairman, ladies, and gentlemen, for your attention to a paper that has unavoidably been fatiguing from the amount of detail it has involved.

## DISCUSSION.

The Chairman said he remembered very well, certainly within 20 years, when it was a dogma of science that no mode of electric lighting could ever be economical, the reason given being that whereas in gas you were digging from the earth raw material, and turning that to effect by very slight mechanical appliances, you had in any form of electrical action to use a manufactured material. This dogma was almost universally held by scientific men. The reason why these developments, which science had given, enabled the problem to be accomplished, was simply due to this fact, that in all of them there was merely a conversion of motion into light. In either one of the machines shown they might use permanent magnets in the first instance. A permanet magnet of course could not go on producing force without being in some way wasted, but they knew that the permanent magnet did go on without any material waste, day after day and week after week, producing the effects desired. This was simply because it was the source of power. The real loss they had to meet was the motive power, whether that were the power of water, steam, or any other force. There, at any rate, was the fact that what it was said it was impossible to do had been done, simply by the application of two principles. In the first place, the admirable idea of using residual magnetism to set up the first slight action which generated by multiplication, the electric current was quite analogous to the principle of Holtz's electric machine, where you had first to get a small amount of electricity which was applied to produce induction in the revolving disc of glass. Again, the great objection to electric light, apart from its use in those obvious cases where you wanted a very powerful light, to throw into tunnels or mines, or anything of that sort, was the glare and the disagreeable effect on the eye. One of these beautiful machines of Dr. Sie-

mens's had been lately exhibited at the Royal Institution, showing a light equal to a thousand candles. But although it was a wonderful light, it was most disagreeable, and he would not have been compelled to sit at work where that was used under any consideration. Now, however, by the simple application of a parabolic reflector, and the system of reflection from the ceiling, the whole of that difficulty was removed. This was very interesting, and it was the same principle in fact as that which microscopists had applied for a long time under the name of "white cloud illumination."

Mr. B. F. Cobb asked for some further information with reference to the figures. In comparing the electric lighting with gas, he understood that the latter came to £144, and against that there were two items of £37 10s., and £35 4s., making a total of £72 14s., or an economy of two to one in favor of the electric mode of lighting. But, in an earlier part of the paper, Dr. Higgs stated that the smallest horse-power required to drive one of these machines was one and a-half or two, and it seemed to him, therefore, that the cost of this motive power required to be added to the figures.

Mr. Ladd had felt considerable interest in the question of electric lighting, having had considerable practice in it, especially in connection with batteries, which, of course, were not suitable where these machines could be used, because batteries wore out, and were not constant. At the same time, he believed he was the first who ever gave a continuous light upon the new principle, with dynamo machines, as they were called. By continuous, he meant a light comparatively continuous. His countrymen seemed to have forgotten this fact, though on the Continent they gave him credit for it. The facts were simply these. When Siemens and Wheatstone, who had been working at the same time upon dynamo machines (first introduced then to the Royal Society) small hand machines, both being presented on the same night, he had been at work in the same direction, but was not aware until then that they could be worked with the mere residual magnetism of iron, and had been working with permanent magnets. When he saw those machines, however, it immediately opened his eyes, and he saw his way to getting a good current. Neither Siemens nor Wheatstone could at that time put their machines to any practical work. They were worked by hand, and the thing soon got into a dead-lock; they could not obtain the power out of the machine. Siemens discharged the whole machine, and got a flash light, not a continuous one, because directly he broke contact the whole machine was discharged, and you had to work it up again. That did not take long, but still it was a flash light, and he believed that was Dr. Siemens' object at that time. Sir Charles Wheatstone, in order to divert a part of his current, put a piece of platinum wire across, which was kept at red heat, diverting a part of the current through it which was made a short circuit, but still the whole thing came to a dead-lock very speepily. In the following month he presented a small machine to the Royal Society, worked by a treadle, and used two armatures, one to charge the magnets and the other to take away the magnetism, and this gave nearly a constant current. That was a very small machine, but it kept a platinum wire very hot any length of time. It did not get into a dead-lock, because the magnetism was carried away by the second armature. In the same year he exhibited a machine of that construction at the Paris Exhibition, which he believed was the first which ever gave a continuous electric light. It excited a good deal of interest, and he had two men to attend to it every day, but, of course, when the electric light had to come out of men's arms it soon got feeble, and directly the light was produced it was found they had to stop and rest. However, the machine excited so much interest, both amongst French and German visitors, that he had a small steam-engine connected with it, and it was worked for hours together giving the electric light. He was quite aware that, in these machines now shown, second armatures were not used, but in the Gramme machine they were, and all he claimed was that his machine was a link in the chain, leading to the present. It had been superseded, because it took a great number of revolutions at a very high speed to get anything like a constant light. These machines, having so many breaks in the circle, did not require such a speed to work them. He believed the electric light would never succeed if a direct light alone would never succeed if a direct light alone were relied on, as it was too painful to the eyes; but it was too weak if shaded, and you would require several to be at all effectual. The arrangement of the reflector, throwing the light up, was certainly very good, but you wanted another one at the top, or else it would give very little light in a room like the one they were in, where the ceiling did not reflect it. With another reflector at the top, which would disperse the light, it would, no doubt, be a very effective plan of lighting. The electric light was now used most successfully in photography, but the direct, or reflected, light was never used on a sitter. Mr. Van der Weyde, of Regent street, used it very successfully with Siemens's machines and a gas engine, and produced some of the best photographs he had ever seen, the half tones coming out most beautifully; but it was all refracted light. It was reflected first from a parabolic reflector placed behind the light, with a piece of metal in front, so that no direct light should come to the sitter; and in front of this reflector there was a prismatic arrangement by Messrs. Chance, and every alternate side of the prisms was either blackened or whitened, so that no light should come direct. If it did so it would show a colored light and surround the sitter with a halo which would not be advisable. The rays of light were made to fall parallel. He had often supplied electric lighting apparatus to photographers, but he had always told them never to get the whole of the light possible from it. You did not want such a powerful light as the carbons would give. What was wanted for photography was a long arc, a number of cells if you used a battery, or a machine with considerable intensity, to give a long arc, and then you got a greater actinic effect. Mr. Van der Weyde told him he never used an arc of less than half an inch.

The Chairman said he presumed that was due to actinism being developed in a certain portion of the arc.

Mr. Ladd said the carbon points themselves gave light, but the arc was the sort of light required for photography. He did not agree with covering the carbons with copper, which he considered objectionable, and knew from much experience that the electric light given by metal was most painful to the eyes. When he had been trying experiments in spectrum analysis he found the light from metal was most painful: why he did not know. He could look tolerably well at the carbon points, but when he began to burn metals between the points he could not endure it, although the light was not so strong.

Mr. Woodall, though he felt sure that Dr. Higgs had desired to state only what had been proved by experiment, was obliged, nevertheless, to take exception to some of his figures. Mr. Cobb had already called attention to one omission. It was certain that any experiments conducted at Mr. Siemens's works would have much care bestowed upon them so as to ensure success; and, no doubt, every reliance might be placed on the results stated; but it must be remembered that the comparison was made between gas purchased from a company supplying it for a commercial profit, and the electric light on the premises of the manufacturer of the machine, nothing being charged except the bare generation of the light. Making the required corrections from this point of view, the cost of gas would be £75, instead of £144, or very little above that of the electric light. The cost of making gas would certainly not exceed the figures given of 2s. per 1,000, and at that rate, taking 120 burners at 6 feet per burner, the cost would come to £72. Then Dr. Higgs put what he called the interest on the cost of burners at 15 per cent., but in the case of the electric light 15 per cent. was made to cover both interest and wear and tear. Now if that were sufficient in the case of a machine going at the rate of 1,000 revolutions per minute, it was absurd to put the same rate on gas fittings nailed to the wall, and never touched perhaps for 20 years. He should therefore take the interest on the cost of fittings at 5 per cent., which would bring the amount up to £75 as the total cost for a thousand hours. But a thousand hours was an exceptional time for gas to be burning in any workshop; 500 hours, indeed, would be a high average, and taking it at that, the cost would come out £39, or very considerably less than the cost of the electric light. As a matter of course, the longer the electric light went on the better would the comparison come out. There was one important omission from the statement, because the £250 would just cover the cost of the machines and lamps, and, if you added the necessary motive power, the shafting, belting, etc., a considerable addition would have to be made to the first cost, and consequently to the items of interest wear and tear. He quite admitted that in large workshops, where power was available without trouble or inconvenience, it might possibly be an advantage to have this exceedingly brilliant light completely illuminating the whole workshop, so that the foreman could efficiently superintend what was going on at any hour, but he maintained that, as a rule, this advantage would be gained at some cost He had some figures, furnished from a workshop at Rouen, which showed that the cost was somewhat above that of gas. He was glad to hear Dr. Higgs say that there were still two fields open for these two modes of lighting. There could be no question that for lighthouse purposes, and in any position where one light of great power and intensity was required, the electric light was superb: but, under present circumstances, and taking this paper as a statement of the present position of electric lighting, they were still only able to hope for such improvements as would render it available for domestic purposes, or where subdivision was required. Dr. Higgs spoke of the Jablochkoff candles as being impracticable, but he believed it was only by improvements in that direction that electric lighting could ever come into competition with gas in its main field. To get the full economical advantage of the electric light, it must be used in centres of great intensity; if it were taken to several points there would be a loss of light in the division. Dr. Siemens had stated, for instance, that the combined currents from two machines would give considerably more illuminating power than the aggregate of the two used separately; and the converse ap-

plied, he believed, to the attempts which had been made to subdivide the current from one machine, there was a loss of power and economy. It was evident also, that, in order to get sufficient light wherever wanted, you must have an excess of light in one particular position, which must be wastefully expended. One point of considerable importance in noting the possible competion of the electric light with gas, was this, that if it were to be brought into practical work, such an amount of apparatus would have to be provided as would be equal to the generation of the whole amount of light required in the time of greatest consumption. A gas company, on the other hand, went on manufacturing during the whole twenty-four hours, and accumulating what was required for the eight hours of greatest consumption. It would, of course, add materially to the establishment charges and to the cost of plant if all the gas had to be generated during the time it was required for use. Electric science had been very happy in the men who had given attention to it, and the enormous progress which had been made in the manufacture of these electric machines was very remarkable. Working it out, he found that the cost, not very long ago, of a machine for producing a light equal to 1,000 candles, was about £350, whereas now the price was only about £35.

Mr. Rochusson inquired what was the chemical composition of the carbon points.

Mr. Mercer did not quite gather from Mr. Woodall whether he had included the cost of motive power required to drive the machine. At the works of Messrs. Siemens that would not be very important, but it would be in places where special motive power had to be provided.

Mr. Woodall said he had referred to that point. There was, he thought, considerable liability on the part of many people, reading figures such as these, to fall into the error that, where there engines on the premises, these machines could be driven by what was called spare power almost free of cost. As a matter of fact, if power were used whether in addition to that already employed or created for the purpose, it must be paid for in fuel.

Mr. Smartt said the use of gas had been spoken of as being 2s. per 1,000, but where he lived it cost 6s.. which would materially alter the calculation in favor of electricity. A short time ago the electric light was introduced into some large premises with which he was connected, and he was informed that it answered very satisfactorily; but he was also told that the success resulted from using the power of one engine and one magnet for producing several lights by means of the new candle lamps. He should like to know the amount of loss arising from using one machine for a number of lights, and how many could be supplied from one machine. He believed it was owing to the imperfect state of the law in Prussia with regard to patents, that Dr. Sitmens was induced to come to England, and we had thus obtained the benefit of his inventions, and he trusted this fact would have weight with the English Government in improving our Patent-laws.

Dr. Higgs, in reply to the observations which had been made, said in regard to the cost of the motive power at Messrs. Siemens's works, as far as he could understand, it cost nothing, because there was always so much excess power that it was not practically noticeable whether the machine was on the shafting or not. Coals had, however, been charged. The machines were charged at the ordinary selling price. As they gave light to a lamp which could be easily moved, there was no expense incurred in following the progress of the work in the shops as might be required; gas fittings had to be taken down and put up, and he had included the cost of this in the 15 per cent., and he did not think this was too much to charge for a large establishment where two gas-fitters were almost constantly employed. Mr. Woodall had referred to the machines as revolving at the rate of 2,000 revolutions a minute, but they actually ran at about 900, the maximum light being given with 1,100 revolutions. The only wearing parts were the commutators. The brushes required renewal about once in two or three months, and as they were simply composed of copper wire set side by side, the cost could not be very great. There were machines which had been in constant use for four years, which showed no signs of wear. He had taken the cost as two to one in favor of the electric light, but it must be remembered that with gas lighting the work was got through very slowly, with great difficulty, and constant complaints of bad gas. In the present case the work was got through much more expeditiously, and if the facility with which the work had been carried on were taken into account, it would add materially to the advantage of electric light; but as this was not a point which could be easily grasped, he had not included it. But there was one substantial point to be noted, viz., that, even in shaded lamps, electricity gave a light six to one higher in intensity than gas. There was the further and immense advantage of distinguishing colors, which could never be obtained from gas. In silk mills this was of great importance. You could distinguish a bluish green from a greenish blue at any time. With regard to the effect on the eyes, where men had to inspect narrow ribbons, or look over narrow slips, and carefully pick out any containing foreign substances, they were not required to look at the light, but at the strips, and if they had an intense light on their work if did not fatigue the eyes so much as a bad light. A bad light was more fatiguing than too good a one. When the electric light was first introduced, the workmen always wasted two or three hours in looking at the light and getting dazzled, but they soon got over the novelty and thought no more about it. The whole subject was very well treated in Fontaine's book on electric lighttng, an English edition of which would soon be published. Throughout that book the same interest was placed on the cost of the electric machines as on the gas fittings, and in correspondence with different French authorities on this matter they said they had carefully considered the wear and tear of the machines, and they d'd not feel justified in putting it any higher. His own experience, both in England and France, led him to concur in that view because, though the machine might be driven at a very high velocity, its mechanical construction and centering were so perfect as to incur only the minimum amount of wear and tear. Bearings would run for a long time at a high velocity, as long as they were truly centered and well lubricated. With regard to the division of the result, the result of the best experiments he had seen showed that a single light gave about three per cent. more light than that developed from 16 separate lamps. He did not say that lightning by 16 separate lamps was a practical success, it necessitated a certain amount of attention, and there were difficulties in the way, but he did not say that they could not be got over. Looking to the great stride made in these machines, they might hope that the solution of the problem of the subdivision of the light was not far distant. With regard to the subdivision of labor and the storing up of lighting power of gas, he would remark that this economy was included in the present cost of gas, and what it would be if supplied without that economy they could not say. At the present time they did not store up force for electricity, but there was no reason why it should not be done; why engines working a certain number of hours should not store up force just the same as was done in hydraulic machines. The electric machines seemed to have the advantage that they could be put up at any time, and in any place, wherever there was motive power to drive them. He was much obliged to Mr. Ladd for drawing his attention to a fact which he did not know before. He was personally acquainted with the Wheatstone machine, and wanted to know where the link was to be found between that and those now used. He could see now where it was. He was much obliged to Mr. Ladd for the information, and it would not be his fault in future if Mr. Ladd's name were not known in connection with this subject. There should have been an upper reflector sent with the lamp, to make it complete. It was generally found that a longer arc gave a greater actinic effect, but less luminous effect. With regard to the coppering of the carbons, the burning of the metal was not perceptible, because the coating was extremely thin. Sometimes he had tried it with a spectroscope, and although, of course, the green copper line was visible, it was not more perceptible than if you rubbed a copper brad along one of the carbon points. He did not think any painful effect would arise from coppering the carbons, but in watching those not coppered, he had sometimes noticed an unpleasant effect produced, due to their heating and spluttering. The chemical composition of the carbon points was a matter of very great importrnce, and there were no less than eight or ten celebrated chemists hard at work trying to make electric carbons which should be homogenous and give a continuous light, but it was a point of great difficulty. The carbons were generally composed of as pure graphite as could be obtained; but, after all, they must go back to the gas companies to get their retort carbons. Carbon points could also be made out of coke; in fact, any pure carbon would do, and the purer the better. The admixture of silica in the slightest degree reduced the illuminating and useful effect, but the addition of oxides of different kinds improved them. Magnesia would increase the lighting effect as 1¼ to 1, and antimony still more. But there was certainly a wide field open to any one who would undertake to provide homogeneous carbons for the electric light.

Mr. Ladd said there was one point which might be worth the attention of chemists connected with this subject. In using these carbons the points were converted into the purest plumbago you could find, and could be used as a black lead pencil. Now it occured to him, if they could get plumbago pencils, they really ought to get better carbons. It occurred to him that it might be possible to pound up pure plumbago, and get better points than were obtained from the retorts.

The Chairman said they were much indebted to Mr. Woodall for so able a statement of one side of the case, especially as the opposite vtew had been so well advocated by Dr. Higgs. They could not doubt that both these interesting forms of light would be very convenient, but there must be great changes indeed before the facility afforded by gas, where you had the gas ready in tubes, and where by turning on the burners slightly or much you could get the requisite amount of light when and where you wanted, would be superseded. They might well be satisfied to see these two kinds of lighting in use side by side. The more they competed, the better for the public, and they might rest assured that with so many able hands at work on both sides the best possible results would be developed. His own feeling was that each had its own special function to perform. He was very glad that their Society had become the repository of so interesting a record as that which Mr. Ladd brought before them, and he was quite sure that any little injustice which Englishmen had done to him would now be rectified. He concluded by proposing a vote of thanks to Dr. Higgs for his interesting paper, which was carried unanimously.

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THURSDAY, MAY 2, 1878.

## Official Report of Examinations of Gas for two Weeks ending April 27, 1878, made at the Photometrical Room of the Department of Public Works.

### Corrected Illuminating Power.

| Date. April, 1878. | Time of Day at which Test were made. | New York Gas-Light Co. | Manhattan Gas-Light Co. | Mutual Gas-Light Co. | Metropolitan Gas-Light Co. | Harlem Gas-Light Co. | Municipal Gas-Light Co. |
|---|---|---|---|---|---|---|---|
| 15 | Between 10 A. M. and 3 P. M. | 17.07 | 17.53 | 20.01 | 16.90 | 19.18 | |
| 16 | | 17.34 | 19.10 | 20.42 | 16.91 | 17.78 | |
| 17 | | 17.00 | 18.69 | 21.52 | 17.05 | 17.65 | |
| 18 | | 16.74 | 18.14 | 22.77 | 16.16 | 16.77 | |
| 19 | | 16.12 | 16.42 | 21.63 | 16.51 | 17.03 | |
| 20 | | 17.40 | 16.65 | 21.29 | 16.67 | 16 98 | |
| | Average | 16.94 | 17.75 | 21.27 | 16.70 | 17.56 | |
| 22 | | 15.56 | 18.01 | 22.27 | 16.58 | 17.19 | |
| 23 | | 17.45 | 17.85 | 22.48 | 16.57 | 16.54 | |
| 24 | | 16.34 | 17.72 | 20.43 | 16.38 | 17.08 | |
| 25 | | 17.18 | 17.98 | 20.56 | 16.11 | 17.19 | |
| 26 | | 17.33 | 17.64 | 21.24 | 17.23 | 16.43 | |
| 27 | | 17.12 | 18.52 | 21.19 | 17.20 | 16.97 | |
| | Average | 16.83 | 17.95 | 21.36 | 16.68 | 16.90 | |

Sugg-Letheby burner.
E. G. LOVE, Gas Examiner.

**Decision in favor of Holly Manufacturing Company.**—An important suit, involving the exclusive right of the Holly Manufacturing Company to construct water works on the direct pressure principle, without reservoir or stand-pipe, has recently been decided by the United States Circuit Court at Indianapolis, Ind., Judge Drummond presiding. The suit was commenced about four years ago, and the decision affirms the validity of the Holly patent.—*Engineering News.*

## Eighth Annual Meeting of the New England Association of Gas Engineers.

[OFFICIAL REPORT.]

[Concluded from page 167.]

AFTERNOON SESSION.

REMARKS OF MR. THOMAS UPON STREET-MAIN JOINTS.

Mr. President and Gentlemen of the Association:—In my early experience with the Williamsburgh Gas-Light Company, with which I became connected in the year 1854, I found pretty nearly all the street mains that were laid were connected with cement joints. While there is no doubt in my own mind that a joint can be made perfectly tight with cement, I much prefer the lead joint. Another thing to be taken into consideration to keep tight joints is, that the mains should be laid a sufficient depth under the surface to protect them from the action of severe frosts. A great many of the mains was not more than eighteen inches or two feet below the surface of the streets, and at this depth in our climate it is a matter of impossibility to keep joints tight, as the action of the frost in winter will displace the mains and cause the joints to leak.

From the bad manner in which our mains were laid, and the cement joints leaking so much, we could not afford to turn gas on during the day. Had we done so we should not have had any to supply the city at night, and we were thus compelled to shut off the gas just as soon as there was any apology for daylight, and keep it shut off as late as possible in the evening. With the most careful working in this manner, for a period of nine or twelve months, our losses from leakage amounted to about 52 to 55 per cent. of the gas manufactured. A great part of this loss was caused by the cement joints leaking, and also a part due to the fact that the mains were not of sufficient depth under the surface to protect them from the action of the frost. As soon as we possibly could I went over the whole of our mains (there was about seventeen miles in all), stripping them, cutting out the cement, and rejointing them with lead; In one season we got the loss from leakage down to 20 per cent., and this with the gas turned on during the twenty-four hours of the day.

One great objection to cement joints is the rigidity of them; in cases where pipe have been disturbed by other excavations and settled, I found in all cases that the mains were broken. In a leading main from our old works, with cement joints, the main, a ten-inch one, was broken entirely off and fractured lengthwise beside, by the upheaval of the ground from frost. In some of the same mains that we had rejointed with lead the mains were drawn apart, drawing the lead out, but with very little loss of gas, as the gasket being driven in tight prevented any great leakage. In cases of this kind the lead was easily driven back and the joint made perfectly tight again. I have never, in our city, put in any streets mains that I have not used lead in the joints, and in laying mains we always make them gas tight with the gasket used. At the present time we have over 90 miles of street mains laid, and outside of our loss from street lamps (we get paid for three feet burners and they average about three and a quarter feet) our loss from leakage will not exceed six per cent.

We have suffered severe loss of gas from sewering in our city. In some cases where there are railroad tracks in the streets, the sewers have been run on both sides of the street, alongside and parallel with our pipe; these excavations are much deeper than our mains lay, and the earth is always filled in loosly and left to settle. In cases of this kind we have had whole blocks of mains dragged down, the pipe broken, and the joints partially pulled apart; at the same time the leakage from the joints was not so great, the gasket preventing the leakage.

In laying street mains what you want particularly to attend to, and especially in the East here, where you have colder weather than we have (we have not seen much winter until we came on here), is to get them down under the surface a sufficient depth to protect them from the frost. With us the least depth is two feet nine inches under the surface of the street, and I am confident could our mains remain in the ground as we put them down, our loss from leakage by them would be very small indeed, while, as I stated in the beginning, I have no doubt that a cement joint can be made tight. I can see no benefit in using cement for the purpose, as I consider lead far superior in accommodating itself to any upheaval or settling of the earth, where the mains are laid down.

Mr. Greenough—I would like to ask Mr. Thomas before he sits down, what the joint-way is to his pipes—his play-way in the bell.

Mr. Thomas—We allow three-eighths of an inch annular space between the hub and the pipe, and the depth of the lead in the socket never exceeds two inches.

Mr. Greenough—What is the depth of your sockets?

Mr. Thomas—The depth of the socket for small pipe, where we order them, is four inches. In buying pipe we have got some deeper in the hub than that, and some of less depth. I consider four inches a good depth of hub for any pipe up to ten inches; above that they ought to be four and one half inches at least, in my opinion.

Mr. Greenough—Do you remember whether the same jointway was in use when you went there as you see now?

Mr. Thomas—In almost all the pipe that we laid, and nearly all of them had cement joints, there was only a small space for jointing, not over one quarter of an inch. In a ten-inch main that leaked at the cement joints there had been tin sleeves put over the whole hub, riveted tight together and then filled in solid with cement, but it was not effectual in preventing the leakage. At this late day if the earth is removed for any cause, where cement is used in the joints, some one will come to the office to inform us of a bad leak of gas at the place; but it is only what was caused by the leakage twenty-four years ago.

Mr. Greenough—What kind of cement do you speak of for cement joints?

Mr. Thomas—Roman, or any good hydraulic cement; there is no trouble in making a hard joint with it. Had our pipe been of sufficient depth, I have no doubt a great many of the joints would have remained tight.

The President—I will state that I have adopted for several years past a policy at the street corners, where connections are made, of making a lead connection, for the expansion or contraction. I very seldom lay a main less than three feet in depth. During the past year our town has been laying water pipes, and I have taken up mains, some three inch and some two inch, that have been laying there for over twenty years, and have taken them in sections to my works, plugged up each end, put on pressure, and found no leak whatever. The great fault I believe lies with a cement joint, or with any joint, in the caulking; it should be almost tight without the cement. At all street corners I use lead. At other places where the pipe is at proper depth, with large bell and socket, I use Roman cement, but with the utmost care in packing—the yarns driven home; and we very often allow gas to flow right straight along. After the packing has been driven men come along and make the joints without one particle of gas following. We used a peculiar kind of hemp this last year, which the water folks use (it was a tarred roping before), which can be used much better; it is common hemp packing. We used before the best of tarred roping from junk dealers, six or seven cents per pound. The common hemp packing is five cents per pound—a pound being lighter, will do double the service.

Mr. Thomas—I will say, while we are on the subject, that formerly we had a good many coated pipes. These pipes were not heavily coated, and in all cases where we had used such pipes, the action of the gas on the socket and spigot end in it has entirely destroyed the coating, leaving the lead loose in the joints, and of course leaking. When I found this to

be the case we burned the coating out of the sockets, and off of the spigot ends, before laying them.

The President—The proper place for tar is on the outside, and not on the inside. Having a surplus of tar for two years past, I have adopted the practice of painting all my mains with tar.

Mr. Thomas—I would not place it on the spigot ends.

The President—We do not put it on the spigot ends. We find that a good way of getting rid of the tar.

Mr. Greenough—You put it into real estate.

The Secretary—I think when this meeting adjourns *sine die*, Mr. Greenough would be happy to see as many as please to accept the invitation, at his works, or at the office, or both. Arrangements can be made so that those who wish to go can take the horse cars. I understand the illuminating-power meter is at the works.

Mr. Harbison—Before we adjourn I would say that I have heard down our way that there have been great things done in the city of Charlestown by the use of a new kind of meter. I would like to have Mr. Neal tell us the results there.

The Secretary—The city of Charlestown is gone—it has passed away. The *district* of Charlestown, Boston, is there; the monument still stands. If it was a pleasant day I should be inclined to ask the gentlemen present to visit the monument. But as it is not a pleasant day I think they had better visit the Boston Gas Works. They will find more to amuse, instruct, and interest them there.

The Secretary—I am called upon to give an account of what is going on in Charlestown. All I can say is this: That being so much occupied with the duties that devolve upon me as secretary of the Association, I cannot give you much information upon the subject at this time. I am using, with other retorts, those called the Davidson retorts. They are of large size and of peculiar shape. You all know how they look. I am using different kinds of coal, and also some oil. The use of the oil, as I said last evening, I do not much approve of; I am not very successful with it. I am satisfied from the very high heats I am carrying, that I make from oil a good deal or soot or lamp black—anything but illuminating gas. I have made, when I was running only three benches of those large retorts (using a mixture of half Province coal and half Westmoreland coal) 55,000 feet to the bench a day. I think if I had been using Westmoreland, or some other good American coal alone, I might have made more than, say 60,000 feet per day.

General Roome—How much coal do you put in a retort?

The Secretary—Over 300 pounds, and the coke comes out in good order. I am not prepared to give any opinion on the subject now. I am using those retorts, and am trying experiments with them. As Mr. Slater remarked, "I have given you an approximate statement of what we are doing, but I cannot give a full statement."

Mr. Harbison—Do you find that carbon collects in those retorts any faster than in the ordinary shape?

The Secretary—When I used the ordinary retorts, before I used these, the carbon did collect; but I never did burn out a retort, or I have not for some years, until recently. I use the McIlhenny process, which I think very highly of. I know it is a benefit to my company. Whether it would be a benefit to any other company I cannot say. But I have used that process for several years and never burned out a retort till within a year. There might have been one or two, or three exceptions. But I have lately burned out retorts with air. I closed up the front of the retorts, or mouth-pieces, and I found that the mouth-pieces were very much heated; even the stand pipes became red hot. I did try the Edge process years ago, and it did not succeed; but I am making experiments with it again. I don't remove all the carbon with steam, but I bring it to that temperature that it can be removed with bars.

Gen. Roome—I have sometimes done that. I do not propose, however, to go into the manufacture of fixed carbon for the sake of furnishing myself with fuel, because I have a great deal of coke on hand, and there is no occasion for manufacturing any more fuel at present. It will save cartage, perhaps.

The Secretary—This relation of my experience may not be very satisfactory to you; but perhaps at the semi-annual meeting I may give a better and fuller account of the Davidson retort.

Col. Armington—What was your experience in following instructions in regard to pushing the coal entirely into the back part of the retort?

The Secretary—I don't think it increased the illuminating power.

Col. Armington—Didn't it reduce it very much?

The Secretary—I cannot say whether that was the effect or not. I have been using some Newcastle coal and that might be the cause of the low candle-power, on one or two occasions.

Col. Armington—Would you recommend to a company, if they tried those retorts, the pushing of the coal to the back end?

The Secretary—I don't think I would. I think it heats the front of the retorts too much, and the mouth-pieces. It would burn off the bolts if arrangements had not been made, by leaving out a brick here and there, near the bolts. I have no cannel coal to mix with caking coal. I add a little oil. The only benefit I derive from the oil is that it prevents the deposit of naphthaline. It generally gathers in the inlet pipe to the holder. I am not using any enriching coal. I think if I were using enriching coal as it is used by some companies, that is, the same per centage and amount, I might show much better results with the Davidson retorts.

Col. Armington—There is another gentleman present who has used Davidson retorts for a few years. Perhaps Mr. Allyn will give us some light upon the subject.

Mr. Allyn—I can endorse what Mr. Neal has said in regard to the Davidson retort.

The President—We have present a gentleman who has tried the experiment with the patent retorts of Mr. Davidson. It is Mr. Sherman of New Haven. Perhaps he can give us some light upon the other points of the question.

Mr. Sherman—The very short time that I have had the retorts in use does not warrant me in going on record either for or against them.

[Considerable discussion of a very indefinite character followed here on this subject.—Ed.]

Mr. Thomas—In a little works that I put up for some parties close adjoining our own city, I furnished them with about two miles of mains, that were laid, and laid thoroughly; and after the works was going along swimmingly and nicely for about a year, they wrote to me that those mains must have been rather bad; they leaked badly, and they wanted me to send some suggestions how they could find the leaks, and they went over them but could not find any. Then they asked me if I would not come up and take a look at them. I went up and took a look at them, and went pretty much all over the town. I could not smell a particle of gas anywhere I went; and there were no paved streets. Then we went back to the gas works and took a look around there, and the first thing I saw there was Davidson's retorts. Their leakage had run up as high as about 50 per cent. I asked the treasurer of the company to just take a look at his book; the yield had been very high, but the loss had been very great. It was a regular index, going over three or four months, that when the yield had been tremendous the loss had been tremendous. He was simply heating up his gas, and probably, as Mr. Armington says, storing it in the holder before it was measured; I suppose the volume had been too great to measure before it got there. When they came back to first principles their loss account went down to what it was before. That is in a little place about twelve miles from where I live.

The Secretary—With reference to the leakage of street mains I would like to ask Mr. Thomas how he corrected that evil. You speak of reducing it down from a very large figure to about 20 per cent. Did you strip the mains entirely, or did you have your men tar down over the joints to ascertain where the leaks were?

Mr. Thomas—You have reference to our own works?

The Secretary—Yes, sir, when you first went there.

Mr. Thomas—We stripped the mains entirely, and in a great many cases lowered the depths of them—dug down and lowered them. In a good many cases we had to straighten them. The mains in our city—the first of them—were laid by contracts. They were on one side of the street; the first thing you knew they were going over to the other side. In digging up and trying to straighten the mains you would have to cut off from six to eight inches to get them straight with the trench. They have got large trees on the sidewalk now, outside of the mains; the mains wind around. And again, if they met a boulder they would dodge one side, and so they kept on cork-screwing it up. How the gas could even leak out of them it puzzles me to discover.

The President—In our town last summer, where we have a long water main, I was obliged to take u a four-inch gas main which was laid by contract when the gas company was first inaugurated. I very soon ound that I had lost the run of my pipe entirely. We dug along and along, and finally, after we got by, we came to a ledge three hundred feet; they had gone on completely around that, and the pipe was completely in the yard of U. S. Marshal Sherman. One of our old citizens, a large stockholder in the company came along, and finding what I was doing in working through that ledge he said, "That is going to cost you a great deal of money." I said "Yes, but Ben Butler taught me something in 1861; that the way to Washington was through Baltimore, and not around it."

Mr. W. W. Greenough—There is one observation made by Mr. Thomas, which leads me to ask some questions, not only of him, but of other engineers present, with regard to the custom of a place when breakages of gas pipes are caused by the employees of the city, or caused by the operations of other corporations, or of individuals working upon the streets. We have been for many years very much troubled, and put to a large expense in consequence of the operations of the city in the streets, causing breakage of our mains, and requiring alterations of them at our own expense, when they were laying either sewers or water pipes, and for that we have had no compensation, because we were to'd that the pipes were in the ground at our own risk, and the city could do with them what they pleased. If a change of the grade of streets was made, as has been so often done in Boston, we were called upon to alter our whole distribution and take up our pipes, without any compensation. It does not seem to be right; but we cannot afford to quarrel with the city. I didn't know but some different custom might prevail elsewhere—but what there might be some place in the United States so healthy as to pay a proper compensation to a gas company for injury done to them by people who take contracts from the city. How is it in New York, General Roome?

Gen. Roome—If in the city for any public purpose our mains are removed, or we are put to any expense, we have a right to protect our own property, and whatever expense we incur becomes a part of the expense of that public work, and is paid for accordingly. *That is the law. The practice is that I never have got one single cent.*

Mr. Greenough—How is it in New Jersey, Mr. Edge?

Mr. Edge—We have met with frequent losses in that way by contractors. The laws do not provide for the payment of any losses by the breakage of street mains. We have on one or two occasions, where the damage has been considerable, recovered a moiety of the expense we were at, from the contractor. That was done under threat of a law suit, and forcing them to pay in a civil suit; but with one or

two exceptions we have not recovered anything. Where the losses are not very extensive we do not notice them. We send at once and repair the damage and nothing more is said about it.

Mr. Thomas—I think only in one case did we ever recover anything for damage to a street main, and that was from a contractor. In removing a boulder for a sewer trench along the side of the street, he blew out six feet of a ten-inch main, and he paid me for that, and I think that was the only instance in which we were paid anything. The city in numerous places out on Greenpoint and in Broadway, in making their excavations, have almost invariably exposed our pipes. In some cases they have dragged down half a mile of main, and that main has been raised up two or three times to the level, and it has settled and settled again and again. I wrote a note to the Department of Works threatening a suit. They have promised to look after the work and protect us, and they have tried to do so since. This one case which I have mentioned, where I received $200, for repairing a ten-inch main, is the only instance where we have got anything.

The President—Mr. McIlhenny is called upon, and he will now please give us the benefit of his experience.

Mr. McIlhenny—In Washington we have had quite as much experience with this thing, in proportion to the size of the city, as any place in the world. All that know anything about Washington know that the conformation of the place has been changed. Some streets have been cut down and other streets raised up. In one year we lowered fourteen miles of street mains; some of those were lowered four or five times, and we raised twenty-eight miles of street mains in the same year. One main was broken thirty-eight times during one summer. And we had five hundred and sixty breakages in our street mains that year, which necessitated the employment of a gang of two hundred men on repairs of mains. We followed up the contractors with two hundred men, plugging up the mains as the surface was torn up. The streets were unpaved then, as you are aware. The contractors would go along with their street plows and tear up the mains, which unfortunately were all near the surface. They would plow up the service pipes and pull them right out of the ground, and as you passed along you might see them sticking up like arrows through the ground. We had no remedy except to go along and plug them up; as soon as we could we relaid them. Our charter protects us in these respects, but at the same time it gives the city the right to alter grades; and under those conditions the gas company have never able to get one cent damages. We did make a claim of $58,000 for altering mains, but we never received a cent. In regard to the sewers the city has been thoroughly sewered. Whenever a main goes down on account of a sewer excavation we have to raise it, and just as the other members have said, we never expect to get anything, and we never make any attempt even to claim anything now.

I would say that during the time that the Board of Public Works, as it is called in Washington, was making these alterations, our leakage only went up two per cent. in that year—we watched it so thoroughly. Of course our expenses for labor were much more. We kept our men on the work right along. We had thousands of plugs turned, and on every main that was broken we just slipped the plugs right in and closed up the apertures.

The President—If there is any gas company represented by any gentleman present, which has been paid by any municipality for any damage done to their (or its) mains, I hope he will let us know.

Mr. White—I can say that while managing the Elizabeth City Company in New Jersey (and New Jersey is where they do everything systematically. They hang a man there when he commits murder, and do not receive the plea of insanity) they always hold a contractor responsible. The contractor is held by the city responsible, both to the water company for its water pipes, or to the gas company for its gas pipe. Where any public improvements were in course of construction, our simple plan of action was that we would follow the work and make a bill for actual damages, if any resulted, and as soon as the work was completed we made our bill and it was presented to the commissioners who had charge of that public work. There was a commissioner for the sewer laying, and by him those matters was made part and parcel of the proper charges against the contractors, and we were in all cases repaid. That was the custom up to the time I left there. The custom in Brooklyn is that you can sue the contractor; whether you can collect anything or not I am unable to say. I found that the judicious expenditure of a few dollars for whiskey with the contractors in that city saved my pipes. If there was a break anywhere in the pipes there was always an Irishman to throw a handful of mud on the place, and send word to the office. I found out very early in my gas experience the immense physical potency of whiskey in matters of this kind, and always apply that experience.

Mr. Harbison—I have had a little experience in Hartford in the matter of the change of grades by order of the City Council. During the past five years we have spent in the neighborhood of ten thousand dollars in raising and lowering pipes, to accommodate the changes of grade; the expense has been borne entirely by the gas company. Our sewers are built under the direction of the Board of Street Commissioners, by contract; and within the past five years the contractors have been in every case required to sign a bond guaranteeing remuneration for any damages which may arise during the progress of their work; and we have, in perhaps a dozen cases, collected the damages from these contracters, through the Board of Street Commissioners. But we have never been able to collect anything from the city proper for any damages which may have accrued to us through their operations. They have presented repeatedly bills to us for repairs of streets, where we have gone along and dug trenches, and a sudden rain has come and settled them, or something of that kind, which bills we have declined to pay, and have offset it by charges against them, which they have declined to pay, for any damages which the city may have caused us. We are protected so far as sewer building is concerned only.

Mr. Greenough—Not to take too much of the time of the Association, I will say that Boston is about to go through a period of internal convulsion in the matter of sewerage. The whole sewerage of the city is about to be reduced to a system, and new and very large sewers are to be laid across the city at various points. Of course it will occasion a great disturbance to previous occupants of the ground. I will do the City Engineer the justice to say, that in making his contracts for the part already directed to be sewered he undertook to guard our interests, but did it in this way: That in case of damage caused to the gas pipes at the corners of streets, where they cross the streets at right angles, the contractor should pay; but nothing was said about the long reach of the street, where the trench for the sewer was to be dug by the side of our main, and where fractures would naturally take place, and where they have taken place already.

The President—When the city commenced last summer to lay mains in our town, we were obliged to take up the pipe I spoke of, the water pipe being laid upon the same side with ours, and we immediately sent a claim to the contractor, amounting to about ninety dollars. In a short time I received a note from the town solicitor, to whom he referred the bill. He said that by the laws of Rhode Island they claimed the right of eminent domain in the streets. We didn't press the matter any further. We found by consultation with our own counsel, that undoubtedly the jury would sustain that view, if the court did not.

The Secretary—You might recover, but it might not be good policy to press your claim.

Mr. Harbison—I have known that in the city of New Haven they have had a very expensive experience in this matter. Before Mr. Sherman went there the loss by leakage was very heavy on account of sewer building.

Mr. Sherman—At the present time we are in the condition that nine out of ten of the gas companies are. We have no rights that anybody is bound to respect.

Mr. Scott—In 1853, when the Waltham water pipes were laid, the damage was considerable (we estimated it at about $3000) from the change of pipes, and the breakage and loss of gas. The Water Commissioners refused to allow us anything. We brought it before the town, and the town voted to pay us about $1,700; about one half of the estimated damage.

Mr. Sherman—I would like to bring out, in marked contrast to this system of confiscation, which seems to prevail all over the country, the example of Worcester. There every cent of damage which the company sustained during Mr. Bullock's administration as Mayor of the city, and during my own as superintendent of the company, was paid most cheerfully by the city. In every contract which the city made for putting down sewers or water pipes it was expressly stipulated that the contractor was to pay the damages. Of course that only applied to the time he was putting down his pipes. The city very justly and generously considered themselves responsible for one year after the work was done, for any subsiding of the earth under their trenches, and made it good to us for one year. We often had to send out and dig up the surface. If it occurred on a sewer connection at any time within one year we used to bring the bill into the city.

Mr. Rollins—Since I have been in Worcester I have had very little experience in regard to this matter of damages—so far as the sewers and water pipes are concerned. Where there has been any damage, there have been a few small repairs. One was in the case of a sewer where they broke a six-inch main, and I calculated that I lost 50,000 feet of gas in one night. I charged that to the city at $2 per thousand, and they paid the bill without any hesitancy whatever. In another similar case I charged them the same. Any damage of that kind they have paid since I have been in charge of the gas works; but in the changing of the grades of streets they have refused to pay anything. I have made out several bills for matters of that kind, and the Commissioners of Highways has refused to approve the bills. The committee who had it in charge said they could not recommend the paying of it unless the commissioner approved the bill. The commissioner said he would not do it at all. I went to the City Attorney and he said that he thought in the matter of highways we didn't have any claims at all, for any damage done by the Street Commissioner in changing the grade of streets. So that in those cases of changing the grades I have not been able to get anything; but in other cases of damages they have cheerfully paid the bills which I have presented.

Mr. Harbison—I think I could suggest a remedy to the gas engineers in relation to this matter, so that they might hereafter collect of the city any damages they might sustain; and that would be by having stockholders elected members of the Common Council.

Mr. Harbison—I move that we now adjourn to meet at the works of the Boston Gas-Light Company.

The President—Of course when we adjourn it will be to meet in semi annual convention at Hartford. What is the pleasure of the gentlemen connected with the Boston Gas-Light Company in respect to the time of our visiting their works? Shall we go there immediately, or is there any special time set?

The Secretary—I think the gentleman connected with that company would like to have us visit their works now, and I will arrange for the honorary members, to take them in a private carriage.

The President—It is suggested that we meet at the Boston Gas Works, at two o'clock.

Gentlemen: Before we retire I would say to you all that I thank you most sincerely for your attendance here, and I hope that at the semi-annual meeting as many of you as possible will be present.

As you separate to-day to go to your several homes, may health and prosperity attend you each and all, now and through the coming year.

Adjourned.

GEORGE B. NEAL, Secretary.

## On Some New Contributions to the Chemical and Technical History of Coal Gas.

BY ALFRED G. ANDERSON, ESQ.,

Professor of Practical Chemistry at Queen's College, Birmingham.

On the board before you I have placed the names of certain bodies which I have no doubt are tolerably familiar to you. They are as follows:

1. ILLUMINANTS OF COAL GAS CLASSED TOGETHER.

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|---|---|
| Marsh gas. | Butylene. |
| Olefiant gas. | Hydrocarbons. |
| Propylene. | Benzole vapor. |

Acetylene.

2. SO-CALLED NON-ILLUMINANTS OF COAL GAS, ALSO ALWAYS CLASSED TOGETHER.

Hydrogen. Carbonic oxide.

I wish to direct your attention to one of these as the suitable representative of class 1, viz., olefiant gas. It is not necessary that I should enter into a minute description of the burner I am about to employ for the purpose of exhibiting its illuminating properties; it is sufficient to say that it is a burner of the Argand construction, by which gas can be burned under the ordinary conditions of admission of atmospheric air to the flame. I have here an arrangement by which I can apply a suitable amount of pressure by means of water supply from this elevated tank, and as this gas is the only representative of the class I am going to bring under your notice, it will be worth while to observe, as far as we are able, the time occupied in its combustion. [Experiment performed; the olefiant gas being burned by the Argand jet, screwed into the top of a graduated glass bottle, as it was displaced by the inflow from a 5-feet head of water in the tank.] I will content myself here with drawing your attention to the light-giving properties of this gas as a fair representative of its class.

Now I pass on to say something of the nature of the *non-illuminating* constituents—carbonic oxide and hydrogen. Unfortunately—although this, I hope, will prove of little importance to us—the duration occupied by the combustion of the bulk of gas we can confine inside this jar can hardly be ascertained with the degree of accuracy I could wish to attain, to enable us to clearly observe the singular contrast in this regard between the compound carbonic oxide and the elementary body hydrogen, to both of which, in a few minutes, I hope to call your attention when burning them by this jet.

Now I must make a remark or two concerning the nature of the non-illuminant bodies—carbonic oxide and hydrogen gas. The former you may probably know is a compound of oxygen with carbon—one volume of carbon vapor being combined with one volume of oxygen. Now I have in this gasholder some carbonic oxide—of which coal gas contains from 5 to 16 per cent.—made a few hours since, and I will transfer a bulk of it into this vessel. For this end I make a communication between the Pepy's gasholder and the gas bottle, with this pipe. Then by the water-pressure, caused by turning this tap, I thus fill the jar with the gas. Now that I have filled the vessel, we will turn down the lights in the theatre, and examine with great care the peculiar blue flame which we shall get when we burn the carbonic oxide by the same burner that we employed in the combustion of the olefiant gas. [Experiment performed.]

I shall draw your attention, in a few minutes, to the nature of the flame presented by the other non-illuminant constituent, and which you see, from the diagram, is called hydrogen. When we then compare the burning flames of the carbonic oxide and the hydrogen, you will at once see that, although these two gases have always been classed together, we shall perceive, by the nature of their respective flames, and their duration of combustion at this burner, that their exists a very manifest difference between them.

We will now, if you please, proceed to compare other results that we shall get by the performance of one or two more experiments, which I must now submit to your notice. Let me first, however, once more repeat the experiment of burning carbonic oxide, as performed in our last experiment. [Experiment performed.]

Now, the flame of carbonic oxide presents a curious circle of spiked points upon the ring of the Argand, and we cannot increase its combustion by this burner without blowing it out, by reason of its inherent limited combustibility.

* * * * * * * * *

We are consuming here a mixture of the vapor of carbon and oxygen, bulk for bulk. Let us not forget this. It is of no use for me to attempt to increase its rate of combustion; if I do so it will inevitably go out. [Shown.] I will increase its supply to the burner to the maximum, and you, I think, will be able to perceive, notwithstanding, how slowly it burns on the surface of the burner; and also when I come to compare it with the other non-illuminant, how slowly it burns in comparison with hydrogen.

We have, in carbonic oxide, a gas which is very rich in carbon, for I have said that every half bulk of it contains nothing but carbon vapor, the rest being oxygen gas; yet we perceive, from these experiments with the burner, that its illuminating power is *nil*. Bulk for bulk, there is just the same proportion of carbon vapor (I may call it carbon 'gas) in light carburetted hydrogen as that contained in carbonic oxide. The only difference is, that the carbon, in the case of the first, is in combination with hydrogen; in the second, of course, with oxygen. But we arrive at a prodigious distinction when we examine the flames of these in regard to illuminating properties. Carbon vapor, united in large proportion with oxygen *or with nitrogen*, though in both instances furnishing highly inflammable gases, can give no light. We most of us, I believe, know, on the other hand, the illuminating brilliancy possessed by all the gaseous compounds of carbon vapor with hydrogen.

Having drawn your attention to the flame of carbonic oxide, I pass on to compare it with the flame which we got emitted from the same burner when we use hydrogen gas.

We evolve hydrogen gas in a moment from zinc; oil of vitriol and some water; and we will fill this flask with the hydrogen gas so evolved, and see its combustion by the same burner. Doubtless you are aware that this non-illuminant is not a compound like carbonic oxide, but what is called by chemists an elementary body. Also, that it forms 1-9th by weight of water, from which it is very commonly prepared. It is found present in coal gas, in proportions generally varying from 25 to 60 per cent. It is highly inflammable.

Now, I may here say that my object to-night will be principally directed to showing you that the two bodies, hydrogen and carbonic oxide, which in this diagram I have placed under one head, in deference to accepted doctrine, as non-illuminants of complete identity, of coal gas, hitherto classed together, have no right to be so classed together. I believe that I shall succeed to-night in demonstrating this to you. They differ in many ways most essentially, and to begin with, we may first with propriety examine the difference in the flames of carbonic oxide and hydrogen, and then I shall proceed to show you that, when burned in association with hydrocarbons, one seriously affects—destroys—their illuminating power to a very great degree, while the other does not.

The flame of hydrogen, I quite expect from your former experience at these lectures, is not unknown to most of you. [Flame from single jet exhibited.]

Now let us see what appearances we get when we burn this hydrogen under the same circumstances as we did the carbonic oxide in the Argand burner, and then compare together the two results. * *

You will notice the peculiar conical shape of the flame of this hydrogen gas. I do not know whether it is perceptible to you at a distance, but it appears to me as a conical bluish-yellow flame. At the upper surface of each hole small sharp-pointed light-colored pencils, somewhat similar to the pointed flame of the carbonic oxide which I was exhibiting a little while since, show themselves.

It is often barely possible, in the limits of a lecture, to do more than bring out evidences of contrast by way of illustration. It must, I think, have been very clear to you that, besides the flames, the duration of combustion observed with carbonic oxide and hydrogen differs in a striking degree. I have hinted that the means at command at a lecture-table do not allow me to prove this with perfect precision before you. But I am able to supply this want from many experiments of accuracy made in my laboratory, and I find that, comparing bulk for bulk, or volume for volume, hydrogen burns in about one-third of the time occupied by carbonic oxide, the same burner being used to consume them.

I need, I think, hardly point out the application of these two duration demonstrations in reference to gas supply. Irrespective of illuminating power, it is obvious that gas containing a large proportion of hydrogen must burn with increased rapidity, and *vice versa* for carbonic oxide. It is an established fact that both of these ingredients in proportion are subject, as I have mentioned, to very considerable variation. Hence may be accounted for considerable discrepancies sometimes observed in meter registration, while the light furnished has been singularly constant.

Well, I want now to show you what is the result of burning half volumes of carbonic oxide, mixed either (by way of illustration) with olefiant gas; or I prefer to take, as more convenient—while yet equally exemplifying what I have to bring under your notice—coal gas. I propose, in a minute or two, to make an experiment founded on this principle—the results are so demonstrative.

This will bring us to the third and last point which I propose to submit to you, regarding these non-illuminants class—carbonic oxide and hydrogen. I shall show that carbonic oxide gas, in a most important way, controls the development of illuminating power in coal gas combustion; so also does hydrogen. I do not propose—time would not permit me—to take the exact photogenic value of gases in which we have the same proportion of illuminating hydrocarbons, mixed in one case with carbonic oxide, in another with hydrogen, for our experiments of comparison; but what I shall succeed in showing to you is this, that where, as in this diagram (No. 2), the non-illuminating ingredients of coal gas are, as they hitherto have been, classed together, it has been done improperly; because the exact part that hydrogen plays, and carbonic acid plays, as constituents of coal gas, has never yet been exactly ascertained; and my inquiries have shown to me that their functions in this regard are entirely different.

Now, having shown you that both carbonic oxide and hydrogen *per se* have no illuminating power whatever when consumed in a gas jet, what I propose to do next is to burn the same proportion of either with a hydrocarbon body like olefiant gas, or with some of the coal gas supplied to this room. The latter plan, I think, perhaps will be preferable, as furnishing the best practical illustration. It is certainly otherwise quite immaterial which example we select. [Experiment made, half a volume of hydrogen being mixed in the jar with half a volume of the gas from the main.] Please observe that, in the case of this hydrogen admixture, a certain amount of illuminating power is developed at this jet; when, however, we substitute for the hydrogen carbonic oxide—[experiment made, half a volume of carbonic oxide and gas being then mixed and consumed]—you cannot fail to note a very marked diminution in the light-affording power of the jet.

I have instituted many carefully conducted experiments, with the view to ascertain the proportion of this reduction; but, unfortunately, it is hardly within the scope of a lecture to bring such exact results under your notice. From measurements of comparison of the two results, I have arrived at this conclusion—

that carbonic oxide in admixture with coal gas reduces the illuminating value of its light-giving ingredients (the hydrocarbons) to the extent of 75 per cent.; that is, supposing we get a light-giving power from admixture with hydrogen equivalent to 1, we get in the case of carbonic oxide substitution a light-giving power equivalent to *one-fourth* only.

These experiments need to be again repeated, in order that we may see perfectly the relations borne by the non illuminants in question to the light-givers.

I will once more, therefore, take this jar, which you will perceive is graduated into divisions, and add to it to the extent of one-half, pure carbonic oxide, after which I shall effect the transfer of another half bulk of coal gas into the jar from this gasholder, and allow them to remain at rest for a few minutes. [Experiment performed.]

I enter into this part of the topic especially—perhaps almost tediously—because I think events will hereafter show that it may become advisable to effect the entire removal of carbonic oxide from coal gas. I think you will be disposed to quite agree with me when you again see, as this experiment will demonstrate, that the mischief done to the illuminating ingredients by its burning in contact with them is very obvious. It probably arises from this cause—carbonic oxide undergoing combustion in atmospheric air produces nothing but carbonic oxide. That gas is said to be a great source of mischief to illuminating power, especially, it has been stated, when more than 2 per cent. of this carbonic acid exists in coal gas.

Now we have our mixture of carbonic oxide and coal gas made; it only remains for us to burn this with the same jet by which I have consumed, you may recal to mind, in the first place, olefiant gas, of the class of the butylene, or illuminating, series; in the next place, carbonic oxide gas and hydrogen, of the non-illuminating type.

I must now beg to draw your attention, as far as the eye can judge from the results, to enable you, if possible, to form an opinion regarding the illuminating power of the gas I am now going to consume. [Experiment of burning the gas with Argand burner and glass chimney performed, as before.] I think the eye, in this instance, will permit you to form a very distinct opinion of the illuminating value of this specimen of gas now burning. Let us recollect that we are here consuming together a certain proportion of carbonic oxide mixed with a certain proportion of Liverpool coal gas, those proportions being equal bulks of each.

We can see there is a material destructive effect produced on the illuminating power of the gas, if you have been able to recall the degree of illumination afforded in the hydrogen coal-gas experiment.

Now, I will take the same bulk of Liverpool gas, and burn it with hydrogen, as a reminder of the effect of the experiment in question. [The jar was half filled with pure hydrogen, and the same measure of gas from the gas supply of the room was then added. After a few minutes rest, the usual water pressure was applied to the lower orifice of the jar, and the mixed gases were burned by the Argand burner as before. Then the carbonic oxide and gas mixture experiment was repeated.] Well, we can now, I think, distinctly perceive that the carbonic oxide of coal gas cannot but be a source of considerable mischief to its illuminating power. We are even unable to see to read with the flame of this mixture—[attempt made]—it is, to my eyes, at least, utterly impossible. In fact, I think you may possibly gather, from the appearance of this flame, that what I have already stated—viz, that this gas gives an amount of illuminating power equal to about one-quarter, as compared with the other gaseous mixture of coal gas and hydrogen—really overvalues its illuminating power.

We will now once more burn the mixture of hydrogen in association with Liverpool gas, having cleared from the holes of the burner a little water, which, by stopping the flow of gas from the orifices of the burner, somewhat interfered with the success of the last experiment made with the hydrogen mixture.

As the last experiment but one illustrating these coatrasts of results, let me draw your particular attention to the greater development of light afforded in this instance. [Experiment performed, the flame burning perfectly.]

It only remains—having in this experiment very correctly ascertained the degree of light which this hydrogen mixture with the illuminating constituents of coal gas affords—to repeat once more, without loss of time (so as to get instant comparison), the experiment of burning them, bulk for bulk, with carbonic oxide. We can then, I feel certain, as the result of our observations, form our conclusions as to the data in a very satisfactory way. (Experiment performed.]

Here we have a very considerable obliteration of the illuminating power of this gaseous mixture. [This experiment was very decisive in showing the great superiority of the hydrogen mixture over the corresponding carbonic oxide experiments.]

I wish to firmly impress upon your minds that it has not been possible for me to institute any more exact means for measuring illuminating power at this table, to be within the limits of a lecture. I have therefore ventured—I fear not without taxing your patience—so to repeat the experiments, that you might be put in possession of a distinct conviction as to the degree of illuminating power which coal gas and light-affording hydrocarbons possess when burned in association with a given volume, on the one hand, of hydrogen gas, and, on the other, the same volume of carbonic oxide.

I have, I hope, now succeeded in actually demonstrating to you, Mr. President and gentlemen, the deleterious effect, upon the illuminating ingredients in coal gas, of carbonic oxide gas. I feel very sure the time will come when you will regard carbonic oxide of coal gas as you do its other impurities and objectional constituents, such as sulphuretted hydrogen, ammonia, bisulphide of carbon, etc., and adopt such means for its removal as science, justified by practical experience, may place at your command And I have also, I trust to your satisfaction, succeeded in showing that the two non-illuminating constituents, hydrogen and carbonic oxide, always present more or less in quantity in coal gas—hitherto held as perfectly correspondent in their peculiar relations to coal gas and its illuminating hydrocarbons—for the future must, in this regard, be dissevered from association.

Now, in regard to taking it out of gas. Well, if we shake up carbonic oxide gas, and what is called cuprous chloride (this used to be called, under the old theories of chemistry, subchloride of copper), this copper salt will absorb every particle of it. The direct absorption of carbonic oxide by cuprous chloride is a reaction remarkable in itself.

I propose to pass some carbonic oxide into this tube. I will show you then that I can absorb it rapidly—in a few seconds. But I may tell you at the same time this fact: that there is nothing whatever—no known means existing—for, in a like manner, absorbing the other non-illuminant—the hydrogen. By burning it with oxygen into water we proceed universally when we desire to effect the removal of hydrogen from a gaseous mixture. As far, however, as carbonic oxide is concerned, I can soon fill this tube with it. [Performed.]

We have it now filled with carbonic oxide, and I will proceed to agitate it with the so-called subchloride of copper. My object, please to recollect, is to show that we can thoroughly absorb the carbonic oxide by agitating it with this metallic chloride.

In the experiment I have just made there is nothing whatever novel. In methods of gas analysis employed during the last twenty years, the cuprous chloride, or the subchloride of copper, has been commonly used for the absorption of carbonic oxide, and when in admixture with other gases; so that in bringing it before you to-night, I simply do so as illustrative of the method by which, should you at any time be desirous, for the reasons I have expressed, and which I hope I have made very patent to you, to remove the carbonic oxide from coal gas, you can do so by using a purifier charged with brushwood over which a subchloride of copper trickles, and there can be no doubt we might find some other metallic solution which would take it out of the gas quite as effectually as the cuprous chloride does. Just as it is considered good policy to remove all the carbonic acid gas by a purifying agent, I am quite sure it would be equally advisable to make a point of also removing all the carbonic oxide.

Well, gentlemen, it only remains for me now to thank you most sincerely for the patience with which you have listened to me. I hardly like to repeat the statement that it has been extremely difficult for me to bring before you to-night such new matter as could be readily appreciated in the form of a lecture; but I think that, when I sum up what I have endeavored to demonstrate before you to-night, you will credit me with the best intentions, if you feel unable to accord me your full praise for telling experimental precision, together with brilliancy of demonstration. I do not think any one can say otherwise than this, as a deduction from the new feature brought before you—*i. e.*, that hydrogen and carbonic oxide have been classed together improperly as non-illuminants. We know now that carbonic oxide hinders illuminating power; it detracts from the illuminants, while hydrogen does not. I have endeavored to demonstrate this to-night, and I think I have succeeded fully in that task.

Mr. Newall—You have shown us the presence of carbonic oxide in gas, would it be too much to ask you to show the best and cheapest mode of taking it out of gas upon a large scale?

Mr. Anderson—I do not know of any other method which will effectually accomplish this, except the use of the subchloride of copper.

Mr. Newall—Would that be an expensive process?

Mr. Anderson—No; for this reason, that the metal it contains would suffer no deterioration. The copper would be of the same intrinsic value after use as it was before; but I could give no idea of the cost of the process. I am simply a chemist, and have no experience in engineering matters; and if I had any opinion on the subject of cost, I should be charry to mention it in the presence of gentlemen so well able to judge for themselves in that regard.

Mr. Newall—Can we extract the nitric acid from the gas, so that it cannot be evolved in combustion?

Mr. Anderson—That I can give an unqualified opinion upon. Unfortunately the small amount of nitric acid produced in gas burning, arises entirely from its combustion in conjunction with the nitrogen and oxygen of the atmosphere. While burning in contact with these two, you have nitric acid produced as the result of oxidation. The gas, as it is sent out from the works, contains nothing of the kind; it is simply impossible that gas can contain it. Nitric acid is a product of the burned gas: which does not exist there before its combustion.

Mr. Braddock—Allow me to ask whether nitric acid is a production of other inflammable bodies as well as of gas.

Mr. Anderson—I should say undoubtedly it is. I should fully expect to find it generated from the combustion of an oil lamp or a candle. What I have stated just now, in reply to Mr. Newell, would show that, I think, pretty clearly.

On the motion of the President, a vote of thanks was given to Mr. Anderson for his lecture, and the same having been briefly acknowledged, the proceedings of the day closed.

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Gas Well at Kansas City.—The National Water Works Company, Kansas City, whose works are located on the bank of Turkey creek, in sinking an artesian well have struck a copious gas stream at a depth of 247 feet. It is supposed that the gas reservoir or vein struck is the same as that on which the famous Wyandotte well is located. The gas will be used as fuel for the water works, thus saving some $3000 per year.—*Engineering News.*

# Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not for publication, unless desired, but as a guarantee of good faith.—Ed

[Special Correspondence of the American Gas-Light Journal.]

### Gas Notes from Ohio.

Columbus, O., April 22, 1878.

It is certainly paradoxical in this age to see a theater that is constructed with every known improvement for convenience, and a perfect presentation of the plays; lit up at night when the great Muse of Tragedy, Melphomene, holds full sway, with the sickly, faint and flickering rays of petroleum. Yet such a scene was witnessed in the Opera House at Pittsburgh, Penn., on the night of Wednesday, April 10th, when the greatest of all tragedies, Hamlet, was produced under the brilliant illumination of tallow dips and sweet scented coal oil. I doubt if Hamlet has seen himself in this 'light" before for a third of a century. The cause of this state of affairs at the Pittsburg theater was a delinquent gas bill.

It appears that the lessee of the establishment, Mr. Gotthold owed a gas bill from last season of some $1,300, attributable to the fact that the season was a disastrous one financially. His bills this year have been promptly paid, but the debt of last year remained unpaid, and the gas company asked a settlement of this balance. Mr. Gotthold stated that he was unable to pay it at the time the bill was presented, and the gas was turned off. This was at four o'clock in the afternoon. At seven o'clock in the evening an employee of the gas company went to the theater and offered to turn on the gas if Mr. Gotthold would make a payment of $250 on the bill. This Mr. Gotthold refused to do, and the gas company's man disconnected the meter and took it away. Mr. Gotthold states that after the old company turned off the gas he requested the new or Consolidated company to make the connections and furnish him with gas; that the president of the new company stated that they would make arrangements to do so, but failed to keep his promise.

The officers of the Consolidated company flatly deny that they made psomises to make connections, and furnish the theater with gas. Such is the story of a delinquent gas bill in Pittsburg, and why Hamlet was produced at the Pittsburgh Opera House under the gamboge rays of coal oil.

It strikes me as something unusual for a gas company to allow a consumer to get in their debt to the extent of $1,300. All gas companies in the State of Ohio, or many of them, require the consumers, if engaged in such transient business as that of running a theater, when making application for gas, to leave a cash deposit sufficiently large to cover his gas bill for two months and a half, or some designated time. A certificate of deposit is given the consumer, and he receives six per cent. interest on his money as long as it remains in the hands of the gas company. In this way the companies are secured against loss. If the bills exceed the deposit the consumer is asked to increase it, and in most cases the applicant consents cheerfully to the demand, looking upon it as a square business transaction.

There is trouble among the stockholders and management of the Citizens Gas Co. at Indianapolis, Ind. It appears that Mr. Mahlon S. Frost, with seven others of the original stockholders of the Citizens Gas Light Co. have filed a bill in the United States Court in that city, asking that a receiver be appointed for the company. The complainants allege the transfer in good faith to the present management, of stock sufficient to give them a controlling interest. They also charge that it now appears that the money with which the stock giving the controlling interest to the present management was purchased, was furnished directly or indirectly by the Indianapolis Gas Co., by persons acting for and in the interest of said corporation, or by stockholders or officers thereof, for the purpose of ultimately destroying the efficiency and ability of the Citizens Company to furnish gas and compete with the Indianapolis Gas Co. They also charge that the present managers of the Citizens Co. are acting in concert and agreement with the Indianapolis Company, or its stockholders, and that the purpose of the present directors of the Citizens Co. is to bankrupt the concern, so that it may not be in a condition to compete with the Indianapolis Company.

The complainant also allege that over $4000 interest on the bonds of the Citizens Company is past due and unpaid, and that by the terms of the bonds, the principal becomes due on failure to pay the interest. They proceed to show that they are stockholders in the Citizens Company, and that their interests may be protected they ask that a receiver may be appointed to take charge of the business and affairs of the Citizens Company, and that the mortgages on the works be foreclosed, and the property sold upon the order of the Court. The Indianapolis Company, or old company, in reply state, that they have no interest, nor never have had in the Citizens Company, and that complaint of Frost et. al,, so far as it relates to them, is untrue.

A suit has been pending in the courts at St. Louis, Mo., for a long time, between the city of St. Louis and the St. Louis Gas Co. The city claim a right to take possession of the works under the original terms of the franchise. Some time ago a lower court in that city, after a hearing of the case, decided in favor of the city. The gas company appealed the case, and on Tuesday, April 16, the Court of Appeals rendered a decision that was also favorable to the city of St. Louis, and fully sustaining the decision of the lower court. The decision has excited considerable interest in St. Louis as well as other Western cities, and has been a prominent topic of conversation among our citizens. The decision of the Court of Appeals is a striking as well as a ponderous document. It takes the broad ground that monopolies cannot exist perpetually upon the strength of "legal quibbles" and that the "public rights cannot be bargained away by officials." The suit involves about two million of dollars. The gas company have appealed the case to the Supreme Court of the State, and if defeated there will carry it to the United States Court.

If the city is finally victorious it will become the owner of gas works properly valued at nearly two millions, and receive the accumulations, or profits, now in the hands of the receiver of the company, said to amount to $400,000; also $40,000 balance due the gas company by the city, and the extinguishment of a debt of the city to the gas company, for gas used by the city pending litigation between the city and company. A receiver has been for some time, and is now managing the works and furnishing gas at $2.50 per thousand. He has been investing the profits in government bonds, pending the issue of the case. The points made in this decision bear interestingly on the situation in gas matters, as now existing in several of our large Western cities.

A sensation was created last week in Louisville, Ky., by the rumor that Mr. John S. Cain, formerly the secretary and treasurer of the Louisville Gas Company, had been found, upon an examination of his books and accounts, to be a defaulter to the gas company to the extent of $50,000.

It is said that there is a shortage on the gas company's books of this amount, but Mr. Cain denies with great positiveness that one cent of it ever went into his pocket. The story told as to how this amount came to be short, and how the money was disposed of, is in substance that the money was used for lobbying purposes in the City Council and State Legislature of Kentucky, in getting a new charter, the old one having expired in 1867.

The charter was obtained, but it is fair to say that the officers of the Louisville Gas Company do not make the charge of defalcation against Mr. Cain, and totally deny that there is a shortage on their books.

The charge is made against Mr. Cain by outside parties, and is brought up in connection with the charge of his having appropriated for his own use the jury fund of the Circuit Court of Louisville. Mr. Cain is said to be a local politician in his own city, of great shrewdness and influence, and is a man that is well liked by all who know him, and who has always borne a good reputation.

In Chicago, during the past few months, the newspapers have set up the usual Winter howl about "cheap gas," and the able editors that know so much, in their own opinion, about the manufacturing and distributing of coal gas, have at frequent intervals told their patrons *exactly* what it cost to manufacture gas to a cent., and *exactly* what gas should be sold for. The people believe every thing they read in their newspapers, and are of the opinion generally, that what their papers don't know about the manufacturing of gas is not worth knowing. On Monday, the 8th of April, the Common Council of Chicago held its regular meeting, and occupied a great deal of time, and developed an extraordinary amount of brains and eloquence (?) in the discussion of an ordinance about gas. After a good deal of sharp talk, *pro* and *con*, the able municipal statesmen of the windiest and most mortgaged city in the world, by a vote of 32 to 2 passed "A Gas Ordinance." I cannot give the text in full, it would occupy too much space; but it gives permission and authority to *any* responsible gas company or corporation, to lay main pipes, feeders and service pipes, upon any of the avenues, streets, alleys, highways, parks and squares of Chicago, provided said corporation gives a satisfactory bond in the sum of one million of dollars, as a pledge that they will comply faithfully with all the conditions of the ordinance. The "terms and conditions" are of such a nature, so complicated and exacting, that it is hardly probable that the existing companies will be annoyed by competitive one's for many months, if not years, to come. The ordinance fixes the standard of gas at fourteen candles, and the price at $1.50 per thousand. In brief it is for "free and cheap gas." The ordinance is beautiful in theory and easy to read; but to pass an ordinance is one thing, and to find a company of capitalists to invest in the manufacturing of gas on such terms is another.

In Dayton, Ohio, the "gas question" has also recently been agitating the public mind. By a law of the State of Ohio, if any city of the State wishing to give the right of streets. alleys, &c., to a corporation for the purpose of laying gas mains and pipes, with the intent of distributing gas to the citizens, a vote at some regular election may be cast by the people of that city, "yes or no," in favor of, or opposed to, the corporation, be it a competitive one or a new organization.

The matter of a new and competitive gas company was brought before the people of Dayton, Ohio, under this law, at the annual Spring election, which took place on the first Monday of April. A count of the votes gave a majority of about 6,000 in favor of a new company. The vote is cast, but will the new company be organized? The truth of the matter is that terms competition or "opposition gas companies," in most cases, simply mean blackmail.

The Mayor of Cincinnati, in his annual Spring message to the Common Council of Cincinnati, recommends the disuse of gas in the public lamps of that city, and the use of gasoline.

This gentleman, whose name is Moore, can hardly be said to belong to the progressive class. Had he suggested the electrical light, people would have given him credit for good sense. His proposition is worthy of the dark ages. In this age it is difficult to understand how he can recommend the use of gasoline in the public lamps of the "Paris of America," which number some 6,000.

The great May Musicical Festival takes place in Cincinnati, during the week in May commencing on the 14th and ending on the 21st, and as a large number of strangers are expected to be present on that occasion, the citizens, ashamed of their moonlight system of lighting their public lamps, have petitioned the Common Council to have the lamps lighted on the festival nights. The Council has not yet acted on the petition.

The streets of Cincinnati are now the poorest lighted of any city in America.

In this city, in Cincinnati, in Louisville and Covington, Ky., in Dayton and Cleveland, Ohio, and several other Western cities, the coal oil men are vigorously canvassing the people, and trying to introduce and sell their oil and lamps. They are having considerable success; not that the people are particularly dissatisfied with the quality or price of gas furnished, but that the agents or canvassers of these coal oil people are so persistent, are such absolute bores, that it is impossible to shake them off or kick them out, and their lamps and oils are bought, the sum asked being a trifling one, simply to get rid of the greatest of all nuisances known in this country, next to a hand organ grinder—an agent for coal oil.

UBIQUITY.

# Gas-Light Intelligence.

## HOW TO BURN GAS.

Under this title a neat little book has been issued containing the paper of Mr. Jas. Somerville, as read at the last meeting at Cincinnati, together with a table, taken from Prof. Chandler's lecture, showing the loss of light resulting from the use of shades, etc., of different kinds of glass. The book is intended for sale to gas companies to distribute gratuitously among consumers. If gas companies can induce their consumers to use better burners and shades one-half the fault-finding will cease. The price is $10 per thousand. Orders may be sent to the office of this Journal.

## OUR EXCHANGES.

### United States.

A NATIONAL GAS WORKS.—A lady just arrived in Washington espied the capitol, and inquired if it wese the gas works. "Yes," said a bystander, "for the nation."—*Exchanße.*

PUBLIC LAMPS IN NEW YORK CITY.—The following were the bids for public lamps, on April 24th, for one year from May 1st, 1878:

| Company. | Gas. | Lamp-Post straightened. | Column releaded. | Column refitted. | Lamp removed. | Lamp reset. | New Lamp fitted up. |
|---|---|---|---|---|---|---|---|
| Manhattan | 12 00 | 1 50 | 1 50 | 3 50 | 3 50 | 10 | 10 |
| New York | 12 00 | 1 50 | 1 50 | 3 50 | 3 50 | 10 | 10 |
| Mutual | 16 65 | 1 | 1 | 3 | 3 | 8 | 8 |
| Municipal | 20 00 | 1 50 | 1 50 | 3 50 | 3 50 | 10 | 10 |
| Metropolitan | 19 50 | 2 | 2 | 3 | 3 | 8 | 8 |
| Harlem | 21 00 | 3 | 3 | 4 | 4 | 10 | 10 |
| Yonkers | 33 00 | 1 | 1 | 2 50 | 1 50 | 8 | 8 |
| N. Y. and N. J. Globe gas-light Company | 20 00 | 1 50 | 1 50 | 3 50 | 3 50 | 10 | 8 |

Contracts were awarded in accordance with the above prices. 500 naphtha lanterns, of the New York and New Jersey Globe Company, were assigned to the Harlem district.

[*Engineering News.*]

GAS FIGHT AT AKRON, OHIO.—All the preliminaries for a gas fight are arranged at Akron, Ohio, the company trying to obviate the ordinance fixing the price of gas at $1.50 per thousand.

FREE TRADE IN GAS.—Chicago has adopted an anti-monopoly gas ordinance, allowing free trade in gas. Any company is permitted to build works and lay pipes under certain general restrictions.

TROUBLE IN INDIANAPOLIS.—The Indianapolis new gas words is in trouble again, the contractors threatening to take possession of the works in default of the interest on bonds.

### Great Britain.

[*Gas Trade Circular and Review.*]

REDUCING THE PRICE OF GAS.—The price of gas is being reduced in several towns; at Plymouth the company have given notice of their intention to reduce it to 2s. 3d. par 1000 feet, and in the neighboring town of Torquay the price is 3s. 6d. per 1000 feet. In these two places we have demonstrated in a forcible manner the various controlling influences which govern the price of gas. For instance, the town of Plymouth is compact with a comparatively small capital, arising from profits formerly obtained, by which the capital was reduced. Their mileage of mains is small as compared with the sale of gas, this being five millions per mile. It has an excellent harbor, with the advantage of a low rate of freight. The coke is sold very advantageously and commands a good price. Lastly, the capital account shows a sale of four million cubic feet of gas for $1000 capital, all of which are highly favorable conditions. Whereas at Torquay the consumption of gas is comparatively small—the district is very extensive; there are few, if, indeed there are any, large consumers; coal is dear, and the capital is necessarily large for their operations. In short the difference is, as the business of a large industrial town, compared with another that may be regarded as a place of resort, principally in the summer months, when the supply of gas is the less required. It may be observed that the present time is an excellent opportunity for gas companies to make additions to their woaks. Pig iron is now quoted at 41s. per ton. Gas mains are lower in price than at any period within our memory. Money is plentiful.

IMPERIAL WATER AND GAS CORPORATION.—On the 28th ultimo, this company was registered with a capital of £250,000 in £10 shares, for the purpose of acquiring and conducting undertakings for supplying gas and water to any place in the United Kingdom, or elsewhere.

LARGE IRON ROOF.—The gas works at the Grasbrook at Hamburg have recently been covered with a gigantic iron roof, constructed by the "Essener Union." Its weight is 51,500 kilogrammes, and its length 84 meters. With the exception of the roof on the Liverpool gas works, it is the largest gas works roof in Europe.

A WONDERFUL DISCOVERY is reported to have been made by an inhabitant of Worcester. A Mr. Stephan has discovered a means of converting steam into gas without "coal, coke, wood, oil, or any other combustible substance or liquid," and at such a cheap rate that the gas can be given away for nothing. A little further on we read that the most valuable results of the manufacture are certain residual products, such as tar, ammoniacal liquor, and lime, which seems to indicate that another dreamer is mixing petroleum vapor with steam, and passing them together through a red-hot furnace. The residual products alone are said to yield a profit of 150 per cent. upon the manufacture. A little tar we can understand, but we do not see the source of the ammoniacal liquor. An exhibition of the process has been made, and it was voted very successful. Certain occult parts of the process are not yet revealed, because the discoverer's patent is not yet fully completed. Commenting upon this process, and the exhibition a writer in the *Worcestershire Chronicle* delivers himself as follows:

"Apart from the lighting question, what a wide field is opened by this discovery of a means of producing steam without coal! The coal trade must of necessity be seriously interfered with. Users of steam and gas can make both the one from the other! A steamship instead of carrying hundreds of tons of coal each trip will not require to do anything of the kind. Keep your gas jets constantly burning under your boilers, and you may make not only steam for driving the machinery, but gas for lighting purposes, and for supplying the said jets. And then you have the residuary products for your trouble."

In face of such a discovery as this, we certainly could not advise the Corporation of Worcester to purchase the undertaking of the gas company. They certainly could not compete with an invention that makes gas of forty candle power a waste product, which may be given away for nothing.—*Journal of Gas Lighting.*

### Prices of Gas Coal.

The removal of some of the restriction placed by the Pennsylvania R. R. Co. and the Baltimore & Ohio R. R. Co., upon the coal produces on the line of those roads, has led to quite a full offering of coal during the past fortnight. Consumers who had not, up to that time, or who have not yet, secured their supply, can do so on very nearly their own terms. The heavy contracts for Westmoreland and Penn coal, made last Fall to cover 1878 requirements, have left but little room for new business in the New York market. A close estimate shows only some 25 or 30,000 tons of American caking coal yet to be contracted for, in New York and its immediate vicinity. At least eight different coal companies are competing for the business, the volume of which would hardly be an object for any of them in ordinary times. In their efforts to secure this trade, the coal companies located on the line of the Baltimore & Ohio R. R. found themselves much embarrassed by the singular claims which the corporation makes, that any reduction in the water freight from Baltimore to New York, below $1.50 per ton, shall accrue to the benefit of the railroad company. It would be interesting to know what particular clause in the franchise of the Baltimore & Ohio R. R. Co. gives them the control of the Atlantic coast, from the Chesapeake to the mouth of the Hudson, and by what right they assume to compel the New York consumer to pay them 25 @ 50 cents per ton for the privilege of shipping coal by vessel from Baltimore to New York. This interference with the right of New York consumers of coal, is being resisted by some of the coal companies who have secured New York contracts, and unless the Baltimore & Ohio R. R. Co. recede from their position, resort will be had, it is said, to the courts for protection. This course will likely expose the whole system of discrimination and private freight rates, under which favored producers have been allowed to secure contracts to the exclusion of others equally entitled to them.

The reduction in the price of gas caking coal at Baltimore and Philadelphia for the New England market, has led to some business in that direction; at $4.00 f. o. b. at Baltimore, and $4.25 at Philadelphia, with the present and prospective low water freight, coal can be delivered to the Sound ports east of Connecticut @ from $5.10 @ $5.15, and to ports east of Cape Cod @ from $5.20 @ $5.25. It will be noticed that these prices range from 25 @ 40 cents per ton less than the same coal costs delivered at New York. This arises from the fact stated above, that under the present agreement between the Pennsylvania R. R. and Baltimore & Ohio R. R. Co., the New York consumer is not allowed to buy his coal either at Philadelphia or Baltimore, and make his own water freight arrangements from those ports. The experience of the present season will give this matter some prominence in adjusting prices in the future.

The low prices of Westmoreland and Penn coal for Eastern shipment, will operate somewhat against any increase of business in the Chesapeake and Ohio caking coals. Some of these coals have met with favor with those who used them last year, and with such will hold their own at about equal cost with other coals. The demand for the Kanawha cannel continues steady. The regularity of shipments, and the facilities offered to the smaller consumers in securing their supplies at short noctie, have led to an extended use of the article, to the almost total exclusion of the imported or other American cannels.

We note the arrivals of the Steamers Pria and Slag at New York from Newcastle, each with about 1,500 tons New Pelton gas coal, imported on orders mainly for reshipment to Sound ports. Two more steamers are reported on the way with the same description of coal. The present freight from Newcastle will allow this coal to be delivered at New York in large cargoes, at from $3.75 @ $3.85 currency, and about $4.50 to the Sound ports.

Provincial coal continues to arrive at New York, at a cost of from $4.00 @ 4.50, depending on quality and port of shipment. The sales of this coal in New England, the coming season, are likely to be materially less than for 1877, the comparative low cost of American coal tending to this result.

We quote the standard coals, viz:

| | At New York. | |
|---|---|---|
| Westmoreland | 5.50 | |
| Penn | 5.50 | 4.00 at Baltimore. |
| Waverly Youghiogheny | 5.35 | 4.25 at Philadelphia. |
| Moore's " | 5.50 | |
| Shafton | 5.40 | |
| Despard Marion, Newburgh Orrel, Murphy Run, Chesapeake and Ohio Agency Coal | 5.25 | 3.85 at Baltimore. |
| | | 5.25 at Richmond. |
| Newcastle | 3.75 @ 3.85 | |
| Provincial | 4.00 @ 4.50 | |
| Cannelton Cannel | 10.00 | |
| Iuce Hall | 8.50 | |

# Reduction in Prices.

SYRACUSE, April 24, 1878.

Editor of the AMERICAN GAS-LIGHT JOURNAL:

My Dear Sir: Having effected a reduction in the cost of manufacturing my Pipe Cutters, I am able to largely reduce the prices, as you will see by the enclosed Reduced Price List, which please insert in my Ad, as per directions.

These machines have now been in use for 2 1-2 years, and is constantly growing in favor. We have numerous testimonials from parties who have them in use.

Gen. Charles Roome writes in January last: "We have two of these Pipe Cutters in use (Nos. 3 and 4, the latter size for nearly 2 years), and they accomplish all that can be desired. No Gas or Water Company would be without the machine after they had once tried it. It is a wonderful advance over the old method in use. There is no jarring of the pipe to be cut, but the machine works smoothly and cuts accurately with certainty and much saving of labor. It is a capital invention."

Chas. D. Lamson, Esq., Engineer of the Boston Gas Works, writes us, April 28, 1877: "The machine which you made us for cutting 36 inch pipe [No. 5] has proved a perfect success. We have just completed the job for which we bought it, and it worked very nicely indeed, giving us perfect satisfaction." * * * "Please ship us at once Nos. 1 and 2 machines."

I can give you many others of like tenor, but select these, as they allude to the different sized machines.

Respectfully yours, &c.,
A. C. WOOD.

## Gas Stocks.

**Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.**

**(with W B Scott & Co.,)**

24 PINE STREET, NEW YORK CITY.

MAY 2, 1878.

☞ All communications will receive particular attention

*Gas. Co.'s of N. Y. City.*

| | *Capital.* | *Par.* | *Bid.* | *Asked.* |
|---|---|---|---|---|
| Central, Westchester | 466,000 | 50 | 75 | 85 |
| Harlem | $1,850,000 | 50 | 90 | 95 |
| Manhattan | 4,000,000 | 50 | 198xd | — |
| Metropolitan | 2,500,000 | 100 | 130 | 133 |
| " Scrip | $1,000,000 | ... | 100 | 103 |
| " Bonds | 500,000 | 1000 | 92½ | 95 |
| Mutual | 5,000,000 | 100 | 75 | — |
| " Bonds, gold. | 900.000 | 1000 | — | 105 |
| Municipal | 1,000,000 | 100 | 95 | 100 |
| New York | 4,000,000 | 100 | 110 | 115 |
| Suburban, W'stch'str | 390,000 | 50 | — | 100 |
| *Gas Co.'s of Brooklyn.* | | | | |
| Brooklyn | 2,000,000 | 25 | 155 | 160 |
| Citizens | 1,200,000 | 20 | 75 | 80 |
| " Scrip | 320,000 | 1000 | 95 | 97½ |
| Peoples | 1,000,000 | 10 | 25 | 35 |
| " Bonds | $ 325,000 | ... | — | 95 |
| " Scrip | 300,000 | ... | 75 | 80 |
| Metropolitan | 1,000,000 | 100 | 65 | 70 |
| Nassau | 1,000,000 | 25 | — | 78 |
| " Ctfs. | 700,000 | 1000 | 96 | 98 |
| Williamsburgh | 1,000,000 | 50 | 103 | 105 |
| " Scrip | | ... | 95 | 97 |
| Union Co. E. N. Y. | | 25 | — | 50 |
| Richmond Co., S. I. | 300,000 | ... | 80 | 90 |
| *Out of Town Gas Companies.* | | | | |
| Bath, Maine | 70,000 | 100 | | |
| Buffalo Mutual, N. Y | 750,000 | 100 | 65 | 70 |
| " Bonds | 200,000 | 1000 | 95 | 100 |
| Baltimore, Md | 2,000,000 | 100 | 134 | 134 |
| " Ctfs., gold | 1,000,000 | | 106 | 110 |
| Bayonne, N. J | | 100 | | 90 |
| Brockport, N. Y | 25,000 | 100 | ... | 80 |
| Citizens, Newark | 918,000 | 50 | 109 | 110 |
| Chicago Gas Co., Ills | | | 150 | |
| " " Bds. | 124,000 | — | 105 | 107 |
| Cincinnati G & C Co | | | | 190 |
| Derby of Conn | 160,000 | 100 | 60 | 80 |
| East Boston, Mass. | | 25 | 132 | — |
| Elizabethtown, N. J. | 300,000 | 20 | — | 130 |
| Fort Wayne, Ind | | 100 | ... | |
| Hannibal, Mo | 100,000 | 100 | 95 | 100 |
| Hartford, Conn | 700,000 | 25 | 184 | 186 |
| Hempstead, L I | 25,000 | 100 | ... | — |
| Jersey City | 386,000 | 20 | 155 | 160 |
| Jamaica, L. I | 25,000 | 100 | ... | — |
| Jacksonville, Ill | 120,000 | 50 | 82 | ... |
| Lewistown Maine | 400,000 | 100 | 70 | 80 |
| Lima, Ohio, | 60,000 | 100 | — | ... |
| Bonds | 30,000 | | 90 | |
| Laclede, St Louis Mo. | 1,200,000 | 100 | 100 | 110 |
| Long Branch | | 20 | 40 | 50 |
| Peoples, Jersey City | | ... | 120 | 125 |
| Peoples of Albany | 650,000 | 100 | - | 27 |
| " Bonds | 350,000 | 1000 | — | - |
| Peoples of Baltimore | | 25 | 51 | 52 |
| " Bonds | | | 106 | — |
| Plainfield, N. J | 80,000 | 100 | — | 105 |
| Perth Amboy | | 25 | — | 95 |
| Rochester, N. Y | | 100 | 50 | 60 |
| Woonsocket, R. I | 150,000 | 100 | 100 | ... |
| Halifax N. S | 400,000 | 40 | 148 | 150 |
| Hamilton, Ontario | 150,000 | 40 | 117½ | |
| San Francisco Gas-Co., S. Fr'isco Cal. | | | 93 | 94 |
| St. Louis, Missouri | 600,000 | 50 | 73 | 75 |
| Stillwater, Minn | 50,000 | 50 | — | 26 |
| Saugerties, N. Y | 15,000 | 100 | 95 | 100 |
| Troy, Citizens | 600,000 | 100 | — | 60 |
| Toledo, Ohio | | | 95 | 97 |
| Washington, D. C | | 20 | 230 | 240 |

The following gas stocks were sold at auction—

60 shares Citizens, Brooklyn, @ 75. 67 shares Williamsburgh @ 102½. 10 shares New York, @ 110¾.

The Manhattan Gas Company have declared a dividend of 5%, payable May 1st.

The New York Gas Company have declared a dividend of 4%, payable May 1st.

COMMITTEE ON STOCK LIST,
NEW YORK STOCK EXCHANGE,
NEW YORK, March 8th, 1878.

Official Statement of the

"NEW YORK MUTUAL GAS-LIGHT COMPANY."

Capital Stock, 50,000 shares, $100 each....$5,000,000
7 per cent. gold bonds due Aug 1st, 1882..$1,000,000
Bond and Mortgage..... 200,000

CONDITION OF THE COMPANY, March 14th, 1878.

Bills payable.....$ 220,000

ASSETS.

| | | |
|---|---|---|
| Cash on hand | $ 76,130 | 98 |
| Coal, naphtha, coke, etc | 63,002 | 52 |
| Outstanding gas accounts | 127,900 | 06 |
| | $267,033 | 56 |

The company has paid quarterly dividends of 2½ per cent. since January 1st, 1875.

OFFICERS.

*President*..... JNO. P. KENNEDY.
*Vice President*..... ARTHUR LEARY.
*Secretary*..... CHAS. PLACE.

# NEWCASTLE AND PROVINCIAL GAS COALS.

THE UNDERSIGNED ARE PREPARED TO EXECUTE ORDERS FOR

**NEWCASTLE COAL** (NEW PELTON),

ALSO FOR THE BEST QUALITIES OF

# PROVINCIAL GAS COAL,

DELIVERED AT ANY PORT IN THE UNITED STATES.

We supplied nearly 100,000 tons of Provincial Coal to some twenty-five different Gas Companies in 1877. These coals will yield in practical use fully

***10,000 Cubic Feet of 16 1-2 Candle Gas---40 Bushels Coke.***

91 STATE STREET, BOSTON. **PERKINS & JOB.** 27 SOUTH STREET, NEW YORK.



DIRECTORS.

| | |
|---|---|
| JNO. P. KENNEDY, | C. VANDERBUILT, |
| C. K. GARRISON, | A. V. STOUT, |
| WM. H. VANDERBUILT, | JOS. SELIGMAN, |
| JOS. HARKER, | GEO. J. FORREST, |
| WM. R. GARRISON, | R. L. CRAWFORD, |
| ARTHUR LEARY, | C. H. KERNER, |
| J. R FORD, | WM. E. HOY, |
| JONATHAN THORNE, | CHAS. PLACE. |

Registrars.—Union Trust Company.

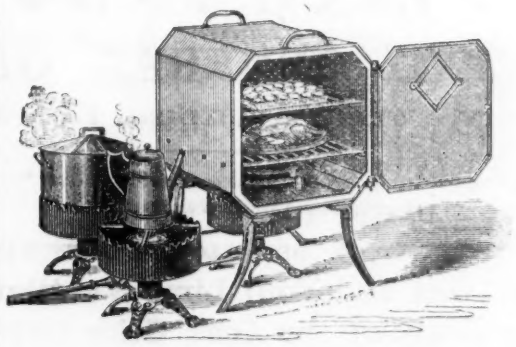
Application is made to have the above stock placed on the list of the New York Stock Exchange.

CHAS. PLACE, *Secretary.*

The Committee recommend that this stock (engraved certificates only) be placed on the free list, and called "New York Mutual Gas Light Company."

AB'M B. BAYLIS, *Chairman.*

*Adopted by Governing Committee, Mar. 27th,* 1878.


The Retort Gas Cooking Stove.

**ECONOMY AND COMFORT.**

JUST THE THING FOR

*Summer Cooking.*

Does not heat the House.
Cheaper than Coal, Wood or Oil.
Actually perfect combustion—hence without Smoke, Smell, or Taste of Gas.
Also, economy over other Stoves.
Over one hundred Gas Companies are selling them to their consumers.
*Every twenty-five in use increase day consumption by 1000 feet.*
Send for circular and reference

**THE RETORT GAS STOVE CO.**

PROVIDENCE, R. I.


## Advertisers Index.


**GAS ENGINEERS.**

| | Page. |
|---|---|
| William Farmer, New York City | 196 |
| James H. Walker and Son, Milwaukee, Wis | 196 |
| George W. Dresser, New York City | 196 |

**GAS WORKS APPARATUS AND CONSTRUCTION.**

| | |
|---|---|
| Herring & Floyd, New York City | 199 |
| T. F. Rowland, Greenpoint, L. I | 199 |
| J. W. Starr & Son, Camden, N. J | 199 |
| Deily & Fowler Philadelphia, Pa | 199 |
| Kerr Murray, Fort Wayne, Ind | 199 |
| George Stacey & Co., Cincinnati, Ohio | 199 |
| Brown & Owen, Philadelphia, Pa | 199 |
| Mackenzie & Sayre Man'f'g Co | 199 |

**GAS AND WATER PIPES.**

| | |
|---|---|
| McNeals & Archer, Burlington, N. J | 198 |
| Gloucester Iron Works, Philadelphia, Pa | 198 |
| Campbell, Brick & Co., New York City | 198 |
| James Marshall & Co Pittsburgh, Pa | 198 |
| R. D. Wood & Co., Philadelphia, Pa | 198 |
| S. Decatur Smith, Philadelphia, Pa | 198 |
| H. R. Smith & Co., Columbus, Ohio | 198 |
| William Smith, Pittsburgh Pa | 198 |
| B. S. Benson, Baltimore, Md | 198 |
| Warren Foundry and Machine Co | 198 |

**PIPE CUTTING MACHINES.**

| | |
|---|---|
| A C. Wood, Syracuse, N. Y. | 201 |

**RETORTS AND FIRE BRICK.**

| | |
|---|---|
| J. H. Gautier & Co., Jersey City, N. J | 200 |
| B. Kreischer & Sons, New York City | 201 |
| Adam Weber, New York City | 200 |
| Gardner Brothers, Pittsburgh Pa | 200 |
| Laclede Fire Brick Works, St. Louis, Mo | 200 |
| Brooklyn Retort and Fire Brick Works | 200 |
| Borgner & Obrien, Phila, Pa | 201 |

**GAS METERS.**

| | |
|---|---|
| Harris, Griffin & Co., Philadelphia, Pa | 202 |
| American Meter Co., Philadelphia, Pa | 203 |
| W. W. Goodwin & Co., Philadelphia, Pa | 203 |
| Harris, Heime & McIlhenny, Philadelphia, Pa | 203 |

**VALVES.**

| | |
|---|---|
| Charman Valve Manufacturing Co., Boston, Mass | 180 |
| Ludlow Valve Manufacturing Co., Troy, N. Y | 201 |

**EXHAUSTERS.**

| | |
|---|---|
| P. H. & F. M. Roots, Connersville, Ind | 200 |
| Smith & Sayre Manufacturing Co., New York City | 202 |

**GAS COALS.**

| | |
|---|---|
| Penn Gas Coal Co., Philadelphia, Pa | 197 |
| Provincial Gas Coals, Perkins & Job, N. Y & Boston | 197 |
| Cannelton Coal Co., " " " " | 197 |
| New York & Cleveland Gas Coal Co., Pittsburgh, Pa | 197 |
| Newburgh Orrel Coal Co., Baltimore, Md | 197 |
| Despard Coal Co., Baltimore, Md | 197 |
| Tyrconnell Coal Co., Baltimore, Md | 197 |
| Fort Pitt Gas Coals | 197 |
| Chesapeake & Ohio R. R. Coal Agency | 197 |

**GAS SCREENS.**

| | |
|---|---|
| Jas. P. Mahan, Boston, Mass | 195 |

**BURNERS.**

| | |
|---|---|
| C. H. Meyer & Co., Philadelphia, Pa | 202 |
| C. Gefrorer, Philadelphia, Pa | 196 |

**PROCESSES.**

| | |
|---|---|
| Gwynne Harris, New York City | 199 |
| Lowe, Philadelphia, Pa | 202 |

**GAS FIXTURES.**

| | |
|---|---|
| Mitchell, Vance & Co., New York City | 196 |

**GAS STOVES.**

| | |
|---|---|
| Retort Gas Stove Company | 195 |

**CEMENT.**

| | |
|---|---|
| S. L. Merchant & Co., New York City | 202 |

**CARBON IN RETORTS.**

| | |
|---|---|
| G. W. Edge, Jersey City, N. J | 201 |

**LAMPS.**

| | |
|---|---|
| J. G. Miner | 196 |

**BOOKS.**

| | |
|---|---|
| Scientific Books | 202 |
| Fodell's Book-Keeping | 203 |
| Kidd's Guides | 203 |

**GAS MACHINES.**

| | |
|---|---|
| Walworth Manufacturing Co., Boston, Mass | 203 |
| Springfield Gas Machine Co., New York City | 203 |



## TO PROPRIETORS OF GAS WORKS & GAS COMPANIES.

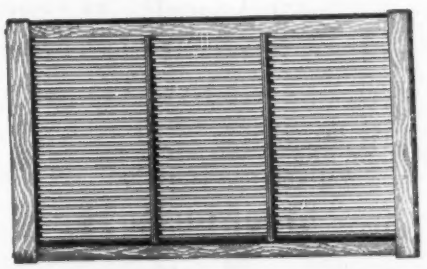
**A Gas Engineer of long Experience,** wishes to rent a Gas Works in the United States, or Canada. Proprietors and Companies of all size Works (large one preferred) that wish to Lease for a term of years, please write and state consumption per day, cost of coal per ton delivered, number of feet per ton, price of coke, price of gas per 1000 cubic feet, number of public lamps, and their price yearly. Also, how old the Works are, and all other information they may think proper to give. Please address J. A. M. P. O Box 2097, New York. 450-6



## Duffee's Improved Gas Screen.

**19 Tremont Row, Boston, Mass.**

JAS. P. MAHAN, Treas. W. H. FRENCH, Agt.


The Screen is made with an ash or oak frame, perforated with ROUND RATTANS, turned and reeved through, drawing the frame firmly together, strengthening it *without the use of nails or rivets.*

This Screen is reversable, can be used either side up, gives a large purifying capacity; there is no clogging by foul lime as the rattan presents a smooth surface and can be cleaned very easily. It is considered by all Gas Engineers who have used it to be the best Screen now in use.

☞ **Samples sent Free to all Parts of the United States.**

All communications should be addressed to

JAMES P. MAHAN,
450-7t 19 TREMONT ROW, BOSTON, MASS.



## AN ENGINEER

**Who has had Practical Experience,**

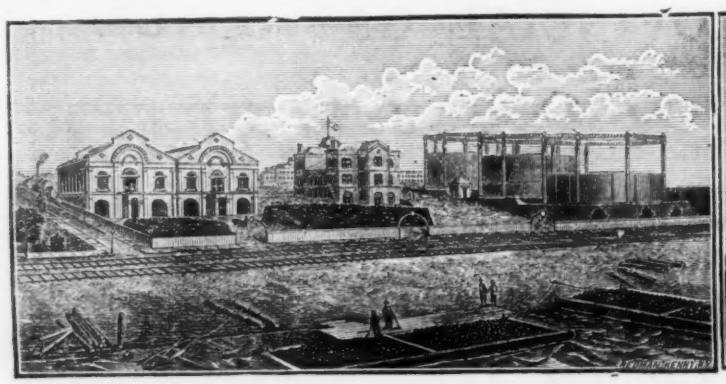
in all branches connected with the manufacture of Illuminating Gas in some very large as well as small works, desires a permanent position. Reference given. Please address C. L., Station D, N, Y. City. 453-1t



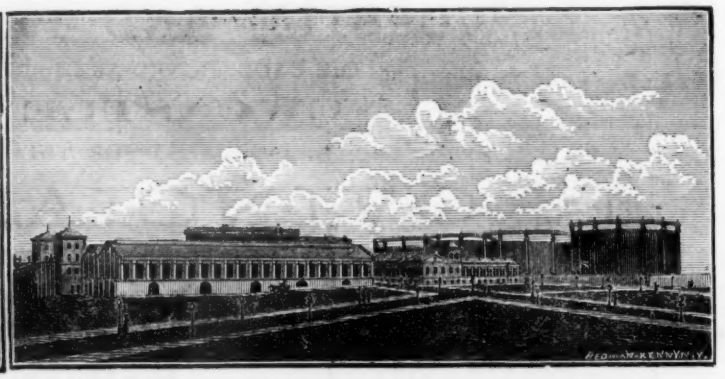
**WANTED---SITUATION**

## As Superintendent of Gas Works.

or would prefer to Lease a Works. Is well known by many Gas Companies. Has Twenty-seven years experience. Best of references. Address OLIVER, care of A. M. CALLENDER & CO., 42 Pine St,, N. Y. 449-tf



CINCINNATI GAS WORKS. ERECTED 1871-72-73.—WM. FARMER, ENG.



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WILLIAM FARMER may be consulted upon all matters connected with the construction of GAS WORKS, or any other description of buildings. Will furnish General and Detail Drawings, Specifications and Estimates for Gas Works of any capacity.

PATENTEE OF THE FOLLOWING INVENTIONS:

Exhausters for Gas and Foul Lime Ventilation,
Dumping Barrows for Coal, Coke and Lime,
Hydraulic Mains for Retort Benches,
Blowers for Forges, Foundries, &c.
Pumps for Water, &c., &c.

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A. W. BENSON, President Brooklyn Gas-Light Company, Brooklyn, N. Y.
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ALEX. McMILLAN, Pres't La Crosse Gas Co.
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And Every Description of

GAS FIXTURES,

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Fine Gilt Bronze and Marble Clocks, warranted best Time-keepers Mantle Ornaments, &c.

Salesroom, 836 BROADWAY.

NEW YORK

Special designs furnished for Gas Fixtures for Churches Public Halls, Lodges, &c.

THE GLOBE STREET LAMP.

*The Globe Street Lamp, in the Different Styles, is offered at Prices to suit the Times.*

For particulars address J. G. MINER, MORRISANIA, New York City.

☞ Any separate parts furnished.

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# GAS COAL COM'Y
### Of Pittsburgh, Pa.

MINERS AND SHIPPERS OF

**YOUGHIOGHENY GAS COAL.**

This Company is prepared to furnish any amount of their justly celebrated, and acknowledged superior GAS COAL, to any point reached by railroad or navigation. on most favorable terms.

**General Office—384 Penn Avenue,**
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**Branch Office—C. & P. RR. Coal Pier**
CLEVELAND, OHIO.

WILLIAM A. McINTOSH, President.
A. CARNEGIE, Vice-President.
W. P. DE ARMIT, Treasurer.
THOMAS AXWORTHY, Agent
351-1y at Cleveland, Ohio.

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THE NEWBURGH

## Orrel Coal Company,

Mines at Newburg, Preston County, W. Va.
Company's Office, No. 52 S. Gay Street, Baltimore, Md.
C. OLIVER O'DONNELL, Pres't. CHAS. MACKALL, Sec'y.
CHAS. W. HAYS, Agent in New York, Room 7, Trinity Building, 111 Broadway.

This Company offer their very superior Gas Coal at lowest market prices.

It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of good illuminating power, and of remarkable purity; one bushel of lime purifying 6,792 cubic feet, with a large amount of coke of good quality.

It has been for many years very extensively used by various Gas Companies in the United States, and we beg to refer to the Manhattan, Metropolitan, and New York Gas Light Companies of New York; the Brooklyn and Citizen's Gas Light Companies of Brooklyn, N. Y.; the Baltimore Gas Light Company of Baltimore, Md., and the Providence Gas Light Company, Providence, R. I.

Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.
224-1y n

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## THE DESPARD COAL COMPANY
OFFER THEIR SUPERIOR
### DESPARD COAL

To Gas Light Companies throughout the country.
Agents, PARMELEE BROTHERS, No. 32 Pine street, N. Y.
BANGS & HORTON, No. 31 Duane street, Boston.
Mines in Harrison County, West Virginia.
Wharves Locust Point, } Baltimore.
Company's Office, 15 German St., }

Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine
*** Reference to them is requested. 204-1

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## TYRCONNELL GAS COAL.,
*MINED IN TAYLOR COUNTY, WEST VA.*
**Company's Office, 52 S. Gay St., Baltimore.**
CHARLES MACKALL, Secretary.
CHARLES W. HAYS, Agent, Room 7, 111 B'way, N. Y.
SHIPPING POINT—Baltimore, Md.

This coal yields 10,000 cubic feet of Gas with an illuminating power of over 16 candles. Forty bushels of very superior Coke, with little Ash and scarcely any clinker 94-1y

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## FORT PITT GAS COAL

This Company is prepared to supply any amount of their
*Celebrated Gas Coal*
to all points reached by rail or lake throughout the West.
**THE FORT PITT COAL COMPANY,**
OFFICE, 337 LIBERTY STREET,
434-1y PITTSBURGH, PA.

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GAS COALS.

## THE
# *PENN GAS COAL COMPANY*

OFFER THEIR

## COAL, CAREFULLY SCREENED,

AND PREPARED FOR

# GAS PURPOSES.

Their Property is located in the Youghiogheny Coal Basin, near Irwin's and Penn Station, on the Pennsylvania Railroad, and on the Youghiogheny River.

**OFFICES**

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**PLACES OF SHIPMENT.**

**Pennsylvania Railroad, Pier No. 2 (Lower Side).**
**Greenwich Wharves, Delaware River.**
366-1y **Pier No. 1 (Lower Side), South Amboy, N. J.**

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# CANNELTON COAL COMPANY
### OF WEST VIRGINIA.

Offer for sale the following Coals, from their Colliery at CANNELTON, Kanawha County West Virginia delivered at RICHMOND, Va.:

## CANNELTON CANNEL,

acknowledged to be the most valuable ENRICHER produced in this country, a gross ton yielding 10,000 cubic feet of GAS of **64·54** CANDLE POWER; COKE **32** bushels, of good quality.

## CANNELTON CAKING COAL.

*MAXIMUM YIELD*, **5.06** cubic feet of Gas per pound of Coal—A yield of **4·78** cubic feet per lb.—gave **16 14-100** Candle-Power.
**COKE**, of very fine quality—**1453** pounds produced from one ton of coal.

SALES AGENTS { **J. TATNALL LEA**, Treasurer, P. O. Box 1747 Philadelphia.
**PERKINS & JOB**, 45 South Street, N. Y.; 91 State Street, Boston.
**H. W. BENEDICT & SON**, New Haven.

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# PROVINCIAL GAS COALS.

The undersigned are prepared to execute orders for the

## BLOCK HOUSE,
## INTERNATIONAL, GLACE BAY,
## CALEDONIA, and LINGAN COALS.

For delivery at any Port in the United States.

**PERKINS & JOB,**

91 STATE STREET, BOSTON. 45 SOUTH STREET, NEW YORK

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# CHESAPEAKE AND OHIO RAILROAD
## COAL AGENCY.

FOR THE SALE OF THE SUPERIOR

# KANAWHA GAS COALS,

ALSO,

## CANNEL,
## SPLINT,
## and STEAM COALS.

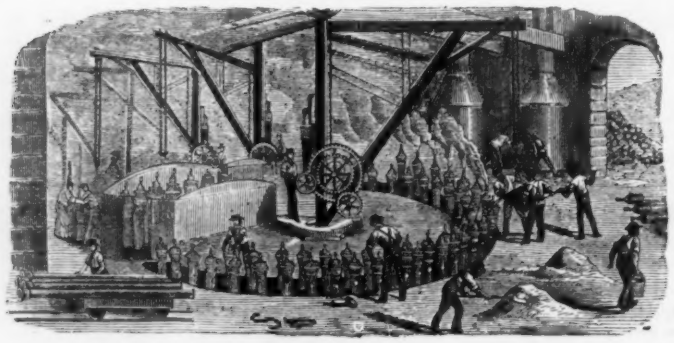
From the Kanawha and New River Regions, on the Line of the Chesapeake and Ohio Railroad.

**C. B. ORCUTT, Secretary.** } {**OFFICE, No. 7 WALL ST**
**J. J. GORDON, Sales Agent.** } { **NEW YORK**

# M'NEALS & ARCHER,

BURLINGTON. N. J,

Flange-Pipes



General Foundry Work.

## CAST IRON PIPES

FOR WATER AND GAS.

DAVID S. BROWN, President.
BENJAMIN CHEW, Treasurer,

JAMES P. MICHELLON, Secretary,
WILLIAM SEXTON, Superintendent.

# GLOUCESTER IRON WORKS,

GLOUCESTER CITY N. J.

## CastIron Gas & Water Pipes, Stop Valves, Fire Hydrants, Gas Holders. &c.

Office No. 6 North Seventh Street, Philadelphia.

ESTABLISHED 1856.

# WARREN FOUNDRY AND MACHINE CO.,

WORKS AT PHILLIPSBURGH, N, J.
NEW YORK OFFICE, 153 BROADWAY.

## *Cast Iron Water and Gas Pipe*

FROM TWO TO FORTY-EIGHT INCHES DIAMETER.
ALSO ALL SIZES OF

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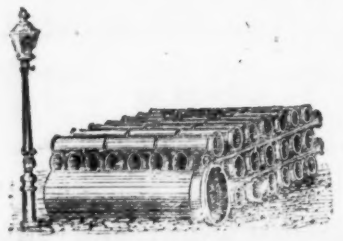

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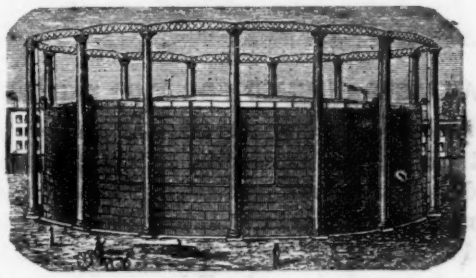

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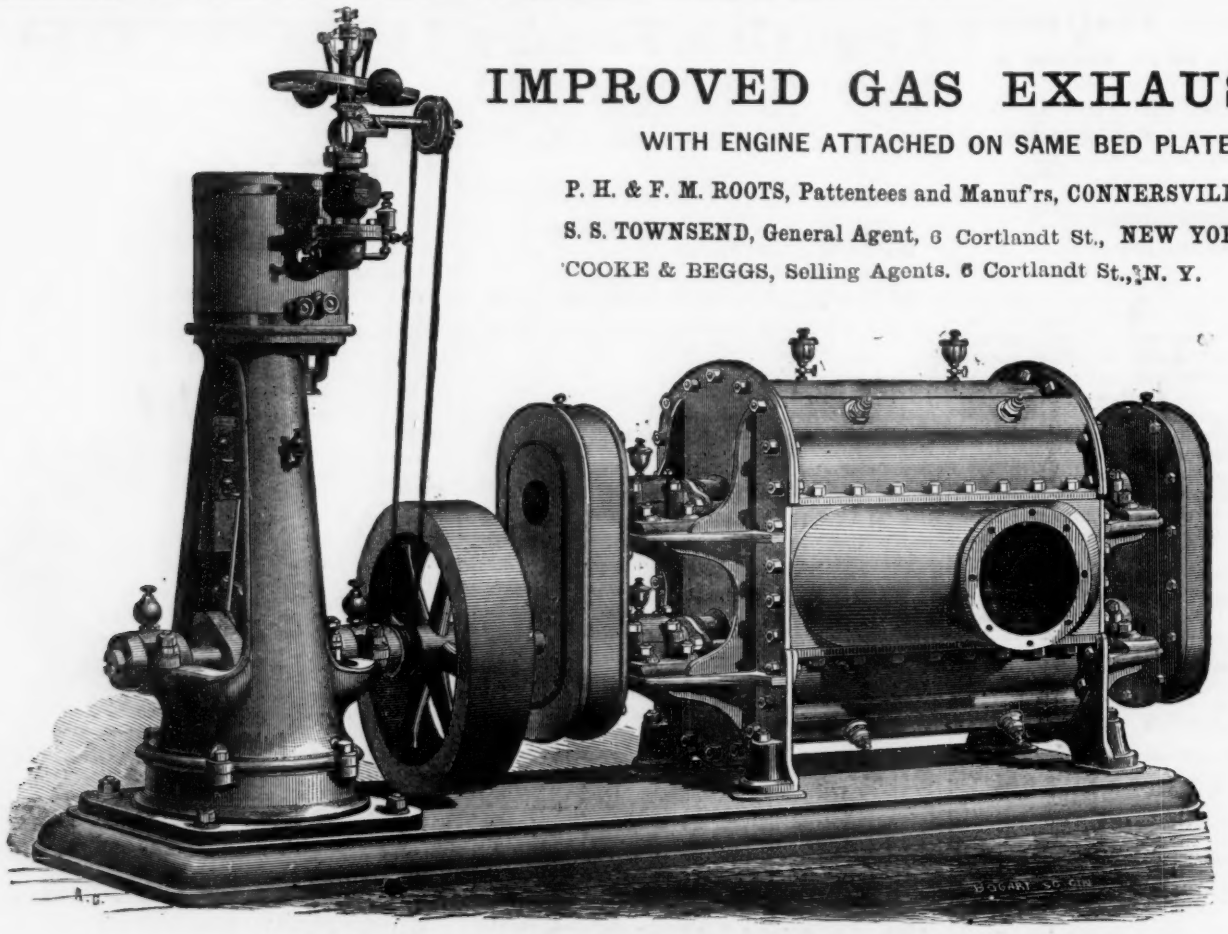

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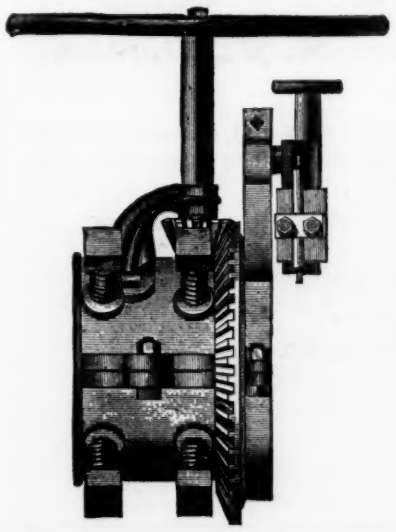

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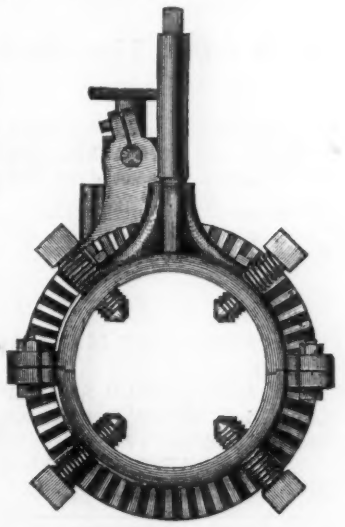

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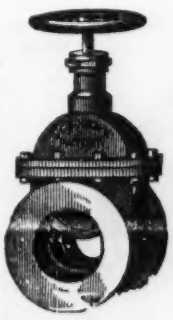

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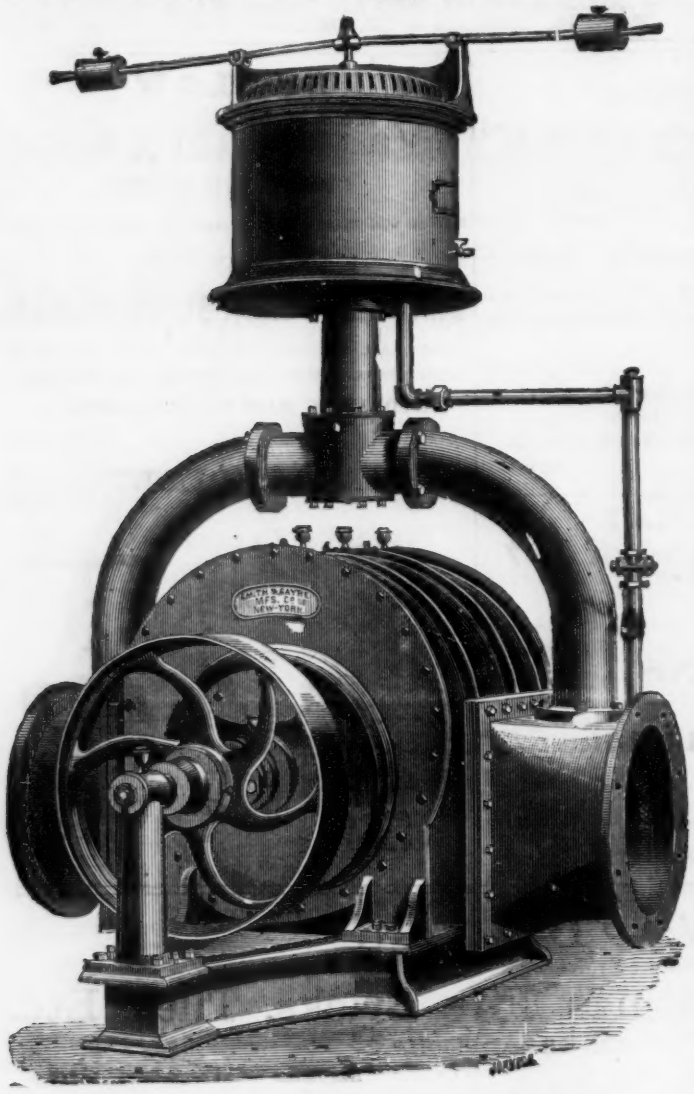


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J. R. HAWLEY, Pres't.
J. L. CAMPBELL, Secretary.

A. T. GOSHORN,
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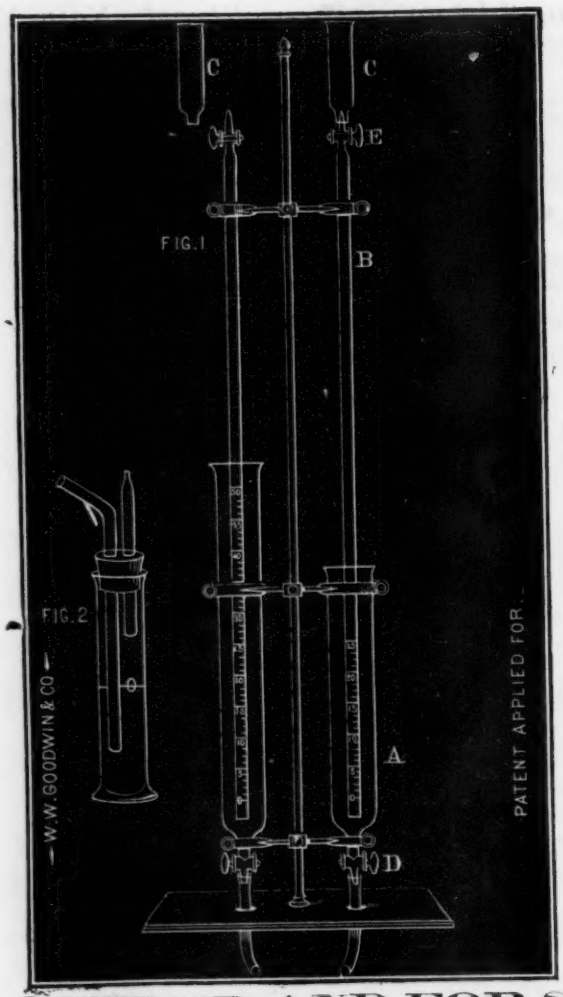


The apparatus will determine the presence of the following gases, and their quantity:

| | |
|---|---|
| Ammonia | ($NH^3$) |
| Sulp. Hydrogen | ($H^2S$) |
| Carbonic Acid | ($CO^2$) |
| Air, Oxygen and Nitrogen. | |
| Bisulp. of Carb. | ($CS^2$) |
| Olefiant Gas | ($C^2H^4$) |
| Carbonic Oxide | (CO) |
| Light Carburetted Hydrogen | ($CH^4$) |
| Hydrogen | (H) |

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